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ON THE COVER: A dramatic photograph of the New Mexico landscape depicts the gathering storms ahead in data communications. The fading importance of voice-grade circuitry, the mainstay of data communications, and other portentious changes to come are captured in the shot by Peter Segal, assistant promotion manager at CW Communications/Inc.

With this Computerworld EXTRA!, *we pierce the dark clouds on the horizon and forecast the developing technologies and techniques that will lead to a bright new day in data communications.*

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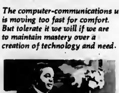

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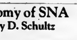

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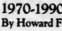

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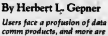

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Technology has outstripped the legal framework. Global conflict is growing between the information "haves" and "have nots."

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digital

We change the way the world thinks.

By Max P. Beere

THE POWER OF TELECOMMUNICATIONS

WE'VE UNLEASHED IT. CAN WE CONTROL IT?

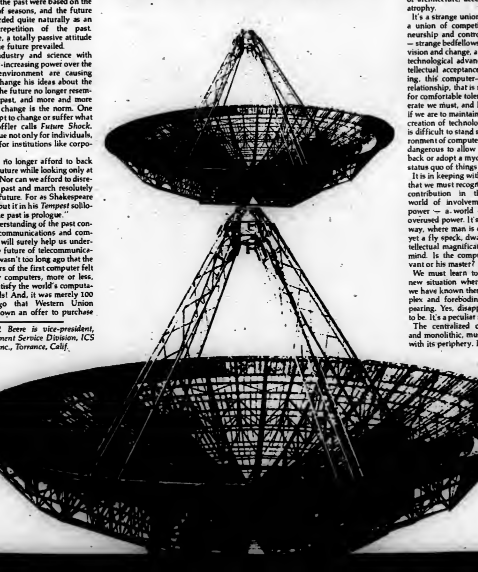
We are living in a telecommunications era that is just now emerging. Telecommunications has not totally emerged yet, but that's because of human frailty, not technological weakness.

For centuries, the idea that the future could be different from the past did not touch even the most intelligent minds. Agricultural societies of the past were based on the rhythm of seasons, and the future was regarded quite naturally as an endless repetition of the past. Therefore, a totally passive attitude toward the future prevailed.

Now industry and science with their ever-increasing power over the natural environment are causing man to change his ideas about the future. The future no longer resembles the past, and more and more dynamic change is the norm. One must adapt to change or suffer what Alvin Toffler calls *Future Shock*. This is true not only for individuals, but also for institutions like corporations.

We can no longer afford to back into the future while looking only at the past. Nor can we afford to disregard the past and march resolutely into the future. For as Shakespeare so aptly put it in his *Tempest* soliloquy, "The past is prologue."

An understanding of the past concerning communications and computation will surely help us understand the future of telecommunications. It wasn't too long ago that the developers of the first computer felt that *four* computers, more or less, would satisfy the world's computation needs! And, it was merely 100 years ago that Western Union turned down an offer to purchase the fledgling Bell System for $100,000 because "the telephone wouldn't amount to anything — it was just a toy."



Strange Union

Today we exist in a world where computers and communications have become inextricably entwined. It's an entwinement of power politics and protocols of services, systems and software; an entwinement of architecture, accolades and, yes, atrophy.

It's a strange union to behold. It's a union of competition, entrepreneurship and controlled monopoly — strange bedfellows. It's a union of vision and change, a combination of technological advancement and intellectual acceptance. It's a blending, this computer-communication relationship, that is moving too fast for comfortable tolerances. But, tolerate we must, and learn it we will, if we are to maintain mastery over a creation of technology and need. It is difficult to stand still in this environment of computer networks, and dangerous to allow oneself to slide back or adopt a myopic view of the status quo of things to come.

It is in keeping with this reasoning that we must recognize our place of contribution in this fascinating world of involvement of uneven power — a world of unused and overused power. It's a world, by the way, where man is omnipotent and yet a fly speck, dwarfed by the intellectual magnification of his own mind. Is the computer man's servant or his master?

We must learn to deal with this new situation where computers as we have known them — large, complex and foreboding — are disappearing. Yes, disappearing, ceasing to be. It's a peculiar metamorphosis.

The centralized computer, large and monolithic, must communicate with its periphery. It reaches out to

Max P. Beere is vice-president, Management Service Division, ICS Group, Inc., Torrance, Calif.

"Man is beginning a new development cycle — that of extending and magnifying his intellect."

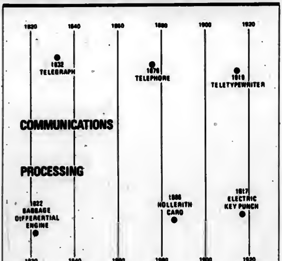


Figure 1: From approximately 1820 to 1930, communications and computing technologies advanced along parallel, but unrelated, paths. An important turning point occurred in 1876 with the invention of the telephone. The telephone changed the form of data from the digital square wave to the enalog sine wave, providing e more powerful base for advances in voice communication technology.

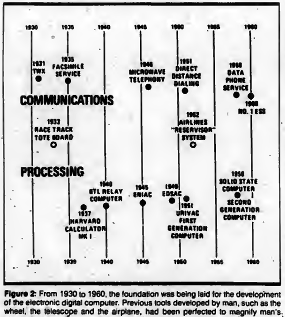


Figure 2: From 1930 to 1960, the foundation was being laid for the development of the electronic digital computer. Previous tools developed by man, such as the wheel, the telescope and the airplane, had been perfected to magnify man's physical power; the computer was the first important new tool designed to expand his intellect. The parallel but unrelated paths of computing and communications began to converge in 1933 when a centralized "counter" was used to calculate the odds at a suburban Chicago race track.

absorb information or data, regurgitating some seemingly cryptic notations understood completely by no one and partially by a rare few. The interesting part — the exciting part — is that as we learn more about computer technology, more about communications (or more properly, telecommunications when dealing with data movement), we are able to make our jobs simpler and more productive. Of course, the computer itself becomes more complex, more self-aiding and more pervasive; thus, we are concerned less and less by it and more and more by what we wish to accomplish with it. The computer *is* disappearing.

While computers appear to be dematerializing, telecommunications services seem to be materializing. We never used to worry about communications; the telephone company did that for us — without choice on our part, I might add. Today, we have a new challenge to explore — the challenge of computer/communications service, and the proffered synergy.

Look Backward

Let's look back to see how we got where we are — somewhere adjacent to a data implosion, not explosion. An explosion we know how to control. We do it every day when we drive our automobiles with their internal combustion engines to work. But an implosion, the sudden release into a vacuum, is very difficult to control, which may be part of our challenge.

If we go back a little more than 100 years (see Figure 1), we can gain a very good perspective because we are about 100 years from Babbage's Differential Engine and Morris' telegraph to today's first on-line, real-time data applications. Up to 1930, communications and computation technology had advanced in unrelated but parallel paths. For the first half-century, the communication industry was satisfied with the digital approach to data transmission as represented by the telegraph invented by Samuel F.B. Morse. In 1876, the invention of the telephone by Alexander Graham Bell changed the form of data from the digital square wave to the analog sine wave, thereby providing a more powerful base for this budding voice communication technology.

In both camps (see Figure 2), even in this early period of development (1930-1960), the foundation was being laid for what was to be one of the most important contributions to mankind — the development of the electronic computer as the tool for expanding and extending man's intellect and the budding communications industry, which was to become the tool to link man's intelligence with it.

Existing Challenges

Since man first stood upright, he has developed tools to deal with existing challenges. Those first tools included clubs, which equalized the primitive homo sapien's chances of survival against such antagonists as the saber-toothed tiger. The club, which magnified man's muscle, gave way to other arm extenders such as the spear, arrow and gun; the wheel lengthened man's legs and lightened his load; the airplane extended his horizons and expanded time; and the telescope has shown him other worlds. All these tools and their many relatives have been perfected and used for thousands of years to magnify man's physical power. Until recently, man has been satisfied with this extension and amplification of his muscle power.

Magnifying Intellect

Now a new era is dawning. In no less primitive sense, man is beginning a new development cycle — that of extending and magnifying his intellect. And that era really began in 1933 when we experienced the marriage of computers and communications.

It occurred at the Arlington Park Race Track in suburban Chicago. The calculation of the odds for the various races was hopelessly slow. To solve this problem, a system was devised that used on-line communications to control every ticket-issuing machine. When the seller pressed a button to issue a ticket, the information was transmitted to a centralized counter. After the counter had been updated, a signal was returned to the ticket machine, which allowed the ticket to be issued. The odds were now readily calculated from the contents of the counter. It was this application that broke the parallel trend of the communications and computations industry and started their inevitable convergence. Also during this time the communications industry developed TWX, facsimile service and microwave transmission.

On the computation side, we see the development of Harvard's Mark I calculator, BTL's relay computer, the Eniac, the first electronic computer and the Edsac, reputed to be the first stored program controlled machine, a concept that will have revolutionary impact on both industries.

Entwinement in Earnest

In 1951, the entwinement of communication facilities and computer technology began in earnest with the development of American Airlines' "Reservisor System." This was an on-line system that connected many outlying locations to a centralized computer via common carrier facilities. Computation for remote locations had been accomplished prior to this, but never via common carrier facilities of this magnitude. Our nonparallel paths started approaching each other at an increasing rate. This event was indeed a significant one, for as fast as the computer industry brought forth a machine to help science and business, the communications industry provided the means to get information from its source to the computation site.

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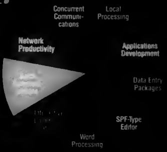

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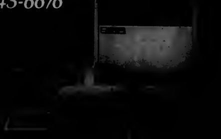

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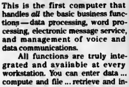

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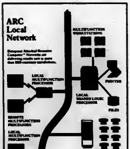
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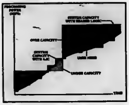

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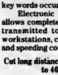

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DATAPOINT

In 1963, with the introduction of Touch-Tone dialing, Picture Phone and graphics display devices, it would seem that business at last had all the help needed to do the computation job. But no! The ultimate, or nearly so, was yet to arrive: Project MAC, in the same year, announced the perfection of work they had been doing in the field of time-sharing a computer with many and diverse users.

This ability of one computer to share its time with many input/output devices scattered throughout the U.S. or even the world, was an event of extreme importance to industry. The giant computer facility was within reach of the small businessman, who up to that time could not afford an installation of that magnitude. Communication and computation became inextricably entwined.

The computer received its share of attention. In 1970 (see Figure 4) the next half-generation was ushered in with the advent of the minicomputer, which served to strengthen the tie and compound the relationship between the two technologies.

According to established patterns, the fourth generation was expected to emerge in 1977, if not sooner. As a matter of fact, it would have made its debut in 1970 but for an interesting set of circumstances: the third-generation hardware was technically ready to be replaced by the fourth, but it had not yet reached financial obsolescence. In addition, third-generation software was not completed until three or four years after its introduction. Software was lagging behind about one-half generation. So to catch hardware up to software, the minicomputer was introduced using third-generation software.

Fourth Generation

If I interpret an article by The Diebold Group correctly, there is good reason to believe that the fourth generation computer will not appear in the marketplace until sometime in the early 1980s. There are three basic reasons why this will occur.

The first reason is a matter of simple economics. The current installation of third-generation equipment will have a delaying effect on the advent of the fourth generation, as equipment installed in the late 1970s will have a useful life of almost 10 years.

The second is technological, and is related to the disparity between hardware and software capabilities. In order to effectively use the concepts characterized as fourth-generation, there will have to be a major breakthrough in the software area. Modular software, written to operate within a flexible architecture and capable of running on a variety of processors, is required. Pressure from users and competition from software companies will cause computer manufacturers to focus their resources and capabilities on the software area. The speed with which software breakthroughs can be accomplished will pace the introduction of the fourth generation of equipment.

The third, and possibly most important reason to management, is the ease of transition that will be mandatory for acceptance of another new generation of data processing. The upheavals associated with previous generations will not be tolerated by today's sophisticated users. The fourth generation must allow for a smooth and gradual transition from previous equipment.

Polyprocessor Reticulum

Expansion in the 1980s will come from gradual addition and enhancement rather than instant replacement of machines. This gradual evolution in the fourth generation era, an era I call the "Polyprocessor Reticulum era," is happening now and is being assisted by the timely introduction of the microprocessor, ROMs, Proms, bubble memories, fiber optics and the whole chip logic eruption, which is also felt in the communications side in solid-state central offices and all digital private lines and switched services.

We are now faced with a problem that can be resolved only by human behavior modification. We must accept the "unity" of the convergence of computers and communications.. We must begin to understand the offspring, for in an evolutionary sense, the parents in their unchanged state *no longer exist*. Consequently, in an effort to bring attention to the existence of the progeny, I gave it a name: Polyprocessor Reticulum (PPR) from poly (meaning many), processor (meaning computer) and reticulum (meaning network of cells or network of needs or users).

The PPR (see Figure 5) idea is born of progress and the marriage of computers and communications technological advancement. It is an amalgam of value-added network services, solid-state switching, microprocessors, chip memories, data base management and terminal advancement — a way to bring the cost of telecommunications down to the worth of the data.

The PPR in theory rushes us into the era of the fourth-generation computer: the Polyprocessor Era! A PPR is a network of intelligent information-processing elements, distributed locally and remotely. It is governed by a software system that enables each module to dynamically alter its basic characteristics to fit the individual's problem-solving needs.

I feel the PPR will be the first evolution not dominated by technology, hardware or the computer manufacturers. The system architecture will be shaped by the computer user and his specific problem-solving needs. Such needs are:

- The appearance of a system dedicated to the user's problem and one he can interface without the intervention of an application programmer.
- The service must be available to the user at all times and optimized to his needs.
- The user wishes only to be charged for the time and resources actually involved in solving a particular problem.
- For the first time the user must be viewed as an integral part of the system along with hardware, software and linkages. We are looking at the introduction of available distributed computer power at up to 100 times the speed and storage capacity of today's

"The PPR will be the first evolution not dominated by technology but by the computer user and his problem-solving needs."

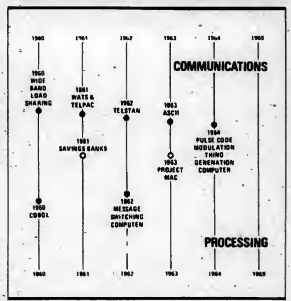

Figure 3: Two other key developments occurred in the early 1960s. In 1961, a real-time, on-line computer debuted at the Howard Savings Bank in Newark, N.J. And in 1963, Project MAC completed work on a time-sharing service in which one computer could service multiple and diverse users, putting computer power into the hands of small businesses. From this point on, communications and computing were inextricably entwined.

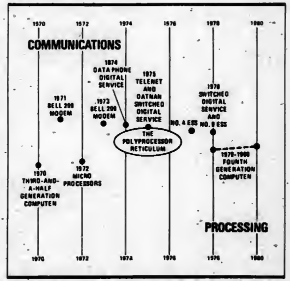
1970
1972
1974
1976
1978
1980
COMMUNICATIONS
1974 DATA PHONE DIGITAL SERVICE
1975 TELENET AND DATRAN SWITCHED DIGITAL SERVICE
1971 BELL 208 MODEM
1973 BELL 208 MODEM
1978 SWITCHED DIGITAL SERVICE AND NO. 5 ESS
NO. 4 ESS
THE POLYPROCESSOR RETICULUM
1978-1980 FOURTH GENERATION COMPUTER
1970 THIRD-AND-A-HALF GENERATION COMPUTER
1972 MICRO PROCESSORS
PROCESSING
1970
1972
1974
1976
1978
1980

Figure 4: The introduction of the third-and-a-half generation minicomputer in 1970 strengthened the ties end compounded the relationship between communications and computing technologies. Fourth-generation computers, expected to emerge around 1977, probably won't appear in force until the early '80s. The fourth generation is expected to be characterized by gradual addition and enhancement rather than instant replacement of machines, an evolutionary process called Polyprocessor Reticulum (PPR).

> "The future is rushing in upon us
> too fast to allow for the comfort
> of doing things the way we always have."

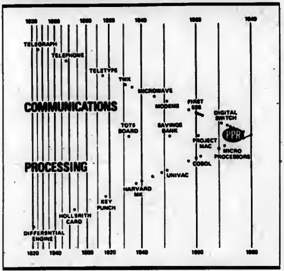

Figure 5: The Polyprocessor Reticulum represents the consummation of computers and communications technological advancement. A PPR is a network of intelligent information processing elements, distributed locally and remotely. The network is governed by a software system that enables each module to alter its basic characteristics to fit the individual's problem-solving needs.

systems at one-tenth the cost. To quote Captain Grace Hopper, USN, "We are looking toward systems of computers rather than computer systems."

Telecommunications managers need worry no further than the plug in the wall: whatever they put in will be delivered correctly to the proper location and at a cost based on data transferred. They will now be able to concern themselves with optimization of the total business system rather than the nuts and bolts of the transmission system. I forsee the day, now starting, when terminals will be plugged in like toasters and business begins immediately with whomever has been authorized for access.

In any evolving technology, there are always more questions than answers. But questions usually mean opportunity. Not easy opportunity in this case, because answers come hard. The network architecture that will be required to meet our future needs has probably not been identified yet; but somewhere, in some company, in some lab, the basis for it *exists*. We don't lack for hardware or the ability to put it together. We are beginning to understand our needs consistent with what's available to meet those needs by way of systems, but we really aren't building them yet. Not the efficient cost-effective nets, not the transparent nets that can meet all needs, all terminals and at a realistic price. We have started, we've begun, but we don't have complete control of the software yet, which means we really don't have complete control of network technology. Not yet.

What this new technological environment suggests is the need for behavior modification on our part. No longer can we depend on the black boxes or the black box mentality of the past — that is, modems, multiplexers, controllers and terminals — to stand alone and do the job they were initially designed to do. The names have not changed, but the unit's capability has. The scattering of logic (microprocessors and memory) into these devices has now made them interdependent.

The user with his black boxes and his black box mentality now exists in a system environment where his communications units are part of a system of distributed logic or distributed processing. What the user needs now is to understand the significance of his distributed logic situation. He needs systems integration and service education. The future is rushing in upon us too fast to allow for the comfort of doing things the way we always have. In order to take advantage of the future, we must release the past. We must dispose of the black box mentality and, through behavior modification, use today's tools to solve today's problems.

In looking toward releasing ourselves from the past, a very important happening has occurred. After the beginning of our "technology era" covering computers and communications, we, the users, were at the mercy of the scientists to develop the systems and services needed to better accomplish our business objections. Sometimes the technologists tried to understand the market and interpret its needs in the form of new computers and new communications systems. Most often, however, the scientists and engineers merely invented what they did best (or had a personal interest in) rather than trying to interpret market needs. Thus, the market constrained its needs to use the products of this somewhat inbred, self-serving technology block. This has not always been the case!

Let's look back one more time for a clue to future solutions.

In 1832, Samuel F.B. Morse invented the telegraph and its alphanumeric code (see Figure 6). He did it because he could understand a need and had the ability to use existing tools to meet that need. Samuel F.B. Morse was not a scientist by trade, but an artist — a painter and sculptor.

In 1876, Alexander Graham Bell invented the telephone, not because he was a great scientist, but because he was close enough to the need as a user to understand the need. And again, he was a man who could understand and use the tools at hand. Bell was trying to invent a "tin ear" so he could better understand how to teach deaf children to speak.

At the turn of the century, an undertaker in mid-America by the name of Almon B. Strowger (see Figure 8) became concerned because he feared that the manual telephone central office operators were misrouting some of his business calls. He invented the rotary telephone switch, sometimes called the Strowger switch, many of which are still in use today. They are only now beginning to be replaced by electronics. Strowger was not a scientist, but he knew what he needed and how to use the available tools to turn a can, some cork, string, pins and wax into one of the great inventions of the 20th century.

The development of the computer over these many years has been so technically forbidding to deal with that only the most dedicated scientific minds could use this tool that magnifies man's intellect! Up to now, that was the case; but it is going to be different. Once we have made the mental readjustment that allows us to understand that the fourth generation computer communications combination has given us an immensely new and useful tool that we, the users, can understand and use, there is no end to what new wonders will emerge from the minds of the actors, the undertakers, the tinkerers, the tailors and yes, even the engineers of today. (We don't make many candlesticks anymore.)

We are entering a new era. We are about to experience a resurgence of needs being filled by the people who *need*! We shall not have to adjust to someone else's interpretation of our needs merely because they can understand the tools of invention. We, the users, now have that power to unleash our minds directly rather than through disinterested third parties.

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"Here are four reasons why we switched to NCR," says Dale A. Dooley of the Iowa Transfer System.

Dale A. Dooley (left) is executive director of Iowa Transfer System, Inc., in Des Moines. Jim Schulte is NCR district manager.

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The Iowa Transfer System is the first electronic funds transfer system to operate statewide. Over 85 percent of the commercial banks in Iowa are supporting members. We recently installed an NCR 8450 as the central element — the switch — in our network.

NCR's SCHULTE:
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DOOLEY:
Our first reason for going to NCR is monetary. With NCR, our costs are substantially lower than under our previous arrangement.

NCR's SCHULTE:
And at least a bit lower than the other alternatives you explored.

DOOLEY:
Then there is the support we received from NCR and from you, Jim. And NCR's known commitment to EFT.

NCR's SCHULTE:
NCR representatives are specialized. All the people in my group work exclusively with financial institutions. So we are in tune with current financial trends. Other NCR representatives have parallel specialties so they can be more responsive to the problems peculiar to their industries. It's a concept that is working well for us.

DOOLEY:
The third reason is software. Only NCR could provide the switch software we needed when we had to have it.

NCR's SCHULTE:
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DOOLEY:
Finally, our decision was influenced by the dependable performance of the other NCR systems within the network. And we have had the same experience with this system. Our uptime level has been very high — a critical consideration when you're talking about a network switch.

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INTERVIEW WITH

People at almost every level of society these days seem increasingly aware of the latest technology and of its growing impact on their lives. Do you think the things that have concerned computing and data processing professionals for years are finally gaining the attention of the general public as never before?

Unquestionably the technology is working itself well beyond the computer cult, shall we say, that has been the primary user of this technology over the last 10 or 15 years. I think this [proliferation into general society] is going to really explode on an exponential growth curve over the next four or five years in terms of the mass consumption of various services that involve data communications.

I think it very likely that the TV set will probably become the most widely used terminal within the next several years. I don't know whether it will be 1985 or maybe a little later than that.

During the 15 years or so that I've been in the business, I've observed that there are always people with a vision of the future who can predict pretty accurately what is going to happen, but what they predict never happens anywhere near as quickly as they say it will. So when one makes rather earth-shaking projections about how quickly these things are going to occur, you can usually slide them out several years and find that to be much more realistic.

To a great extent this goes to the heart of your question. You can have all this technology. But if the masses who are potential users of that technology are not educated sufficiently to appreciate what it can do for them, you will find it going to waste. A lot of the shortages [of skilled personnel] in data processing and certainly in data communications have led to much of the delay that has occurred [in delivering new generations of products].

John McCarthy, a winner of the [Association for Computing Machinery's] Turing Award, observed that in the first three or four decades after the advent of the computer there has been no real revolution in the way people live comparable to what occurred after the invention of, say, the light bulb or home refrigeration. But he added that the "computer revolution" is now just about to begin with a vengeance because the technology is entering the public consciousness through the home and education. Do you agree?

I don't think we can talk only about the computer revolution now. We have to tie in telecommunications in its purest form. I am really referring to the combination of computer technology, telecommunications and the energy situation, all of which will collide at a certain point in time.

It's very obvious to me that the days of people jumping on airplanes and flying casts of thousands to business meetings are fast going into the past. Telecommunications technology, which to a great extent will be a major user of computer systems not only as an integral part of controlling a network but also as an end user of these systems, will become a very real and bona fide substitute for a lot of physical travel in business.

This is not a new concept at all. But I think we'll find in the next several years a lot of people using telecommunications and teleconferencing — in fact being forced to do so by their organizations — to carry on business meetings and perform their jobs in a way that involves massive uses of telecommunications, whereas in the past it may not have involved any use of telecommunications whatsoever.

Lewis Branscomb, IBM's chief scientist, said recently that telecommunications might have just the opposite effect. That is, teleconferencing and electronic mail systems might increase rather than reduce travel by freeing up business executives to spend more time on interpersonal relationships.

I would agree that certain types of individuals will be freed up. Business, let's face it, will always be carried out between people, and there is no technology anywhere that is ever going to change that. But what you will find is that the number and kind of people who will be influenced as Dr. Branscomb suggests will be rather small, although they will be freed up from much of the drudgery of business meetings today.

Twenty years ago, did you foresee a lot of what has since happened in the technology, or have you been amazed at the rate of progress?

I have not been all that amazed by what has come into the market in the area of telecommunications technology.

One thing you do learn when you study technology in a university environment is that you tend to be uncontaminated by the political

DIXON DOLL

Dixon R. Doll loves to express an opinion. Doing just that, as one of the world's best-known consultants and lecturers on data communications and distributed processing, the 38-year old president of The DMW Group travels widely, but has kept Ann Arbor, Mich. — where this interview was conducted just before Christmas last year — as home base.

Still serving as a member of the graduate faculty at the University of Michigan, where he earned master's and Ph.D. degrees in electrical engineering, Doll lives with his wife and three sons a few miles from the university campus and also near headquarters for DMW Group, a fast-growing consulting and software marketing firm he cofounded in 1971. Doll is also an adjunct staff member at the IBM Systems Research Institute.

As a speaker, Doll's delivery is robust and matter-of-fact. His resonating baritone voice usually has no trouble reaching the end rows in a conference hall on his many speaking engagements. And those halls are usually packed when the author of *Data Communications: Facilities, Networks and Systems Design*, a best-seller in its field, expounds on the strengths and weaknesses of vendor offerings, best approaches to strategic planning for networks and ways to enhance a data communications career.

Doll has also been active in regulatory matters. He advised a large telephone company on a Federal Communications Commission proceeding and gave expert witness testimony to public utilities commissions in New York and Michigan and in two major antitrust suits: MCI Communications Corp. vs. AT&T and Memorex vs. IBM. He was retained by IBM to train salesmen of the Series/1 minicomputer in data communications.

Brad Schultz

dimensions of the business world. You tend to view things more in terms of what they could be rather than what they really are. So some of the basic characteristics of satellites, very intelligent networks and all the good things that have taken the world by storm in the last couple of years were things that I could pretty easily see coming into their own in time.

What was hard to appreciate 15 or 20 years ago was how unbelievably difficult it really is for a lot of these things to happen, given the constraints imposed by very large organizations. The best example I can think of is Bell's Advanced Communication Service (ACS). That is a networking technology and a concept that they must have had in the laboratory for a minimum of 15 years, if not longer. But taking a behemoth like ACS from the laboratory into the marketplace in a meaningful way is really incredible.

How did you get into telecommunications?

I was working at the Systems Engineering Laboratory at the University of Michigan. We had a large number of graduate students who were concerned with various aspects of modeling time-sharing systems and building queuing models of operating system behavior. I decided that I didn't want to be Serial No. 32 in that long line of people coming out of there, so I shopped around with two or three of the professors I knew on campus who I thought

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had a good vision of the future. I also evaluated them as people. I found one that I had a very high regard for who is now the chairman of the department at Princeton, Bruce Arden. He suggested in 1964 that communications was the place where all the action would be in the '80s. He accurately indicated that there would be an unlimited amount of opportunity for anyone who wanted to go into that area.

I found in that setting that I had to educate myself. It became necessary not only to educate myself but also to educate some of the other members of the faculty about some of the dimensions of the communications game that I was working in so that they could appreciate the nature of the contribution.

One funny story came out of the process of getting my dissertation. The problems that we face in optimizing communications networks to a great extent are so complex that they defy any types of traditional analytic methods and closed forms solutions. My view was that the contributions had to be evaluated in a completely different way. I thought it would be a cop-out not to work on those problems just because we couldn't solve them with traditional mechanisms. So we had to ask how we could compare different techniques in very complex problem-solving areas. What we came out with was that people use heuristic procedures or approximation techniques that compromise the costs of finding a problem, the amount of computer time it takes and the quality of the result.

My view was that a good heuristic that could be shown to be better than anything else that had been published in the problem area was a very significant contribution. I don't claim that I made one, but I think there has been a lot of change in mentality and attitude in the academic community over the last 10 or 15 years to modify their behavior and to be willing to accept solutions to problems that are complex enough to defy the traditional ways used to satisfy degree requirements.

I did finally successfully convince the people at the university that an improved heuristic was a contribution. That was the biggest difficulty I encountered.

There still seems to be a tendency by researchers and developers to try to produce an all-purpose solution to a very complex problem. Isn't the need, rather, to break up those huge problems into smaller ones and to make solutions more flexible?

I very definitely agree that the complex problems have to be broken up into sub-problems. In fact, that's one of the things that must be done in managing any large organization. But care has to be exercised in deciding how to break them up.

I go back time and time again to the lesson that this industry never seems to learn, and that is they think that they can throw more and more resources at a really tough problem like the ACS software. It probably turns out that the optimum size group to solve a problem like that is somewhere in the vicinity of 10 or 20 extremely smart people who are given a specific statement of objective, told to go off on their own, given all the support they need and told not to come back without the answers to the problems.

When we throw more and more people at a problem it makes problems get worse rather than better. That is one of the lessons that our industry hasn't learned yet, and I continue to be amazed at it. You can cite from half a dozen to a dozen extremely major projects in this industry that have failed because top management decided they could be solved by throwing more money and people after the problem and did not compartmentalize them in the correct way.

You've referred frequently to the past. When did data communications actually begin?

A few companies were using data communications in the late '50s and early '60s, but it probably never began to be identified by even the professional community as a discipline until the mid-1960s. It was then that some companies first began to develop products that could send binary signals and messages over telephone lines.

How would you define the relationship between data communications as a discipline and computer science and data processing?

If we compare data processing and computer science, I simply view computer science as a discipline which is concerned with designing machines — the computers themselves and various supporting products . . .

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"The telecommunications utility is easy to define, but the technology to provide it is not in the marketplace today."

. . . It's also been called the science of algorithms . . .

. . . That's right, but that would be a subdiscipline. I think you need to worry about more when you're studying how to build computers than simply algorithms.

Data processing, by complement, is the science or the discipline or the profession of using information systems to their greatest advantage.

In data communications, the technology has followed just like the computer discipline. The people primarily regarded as the gurus of the industry were the ones who were concerned with developing products, machines and networks that would provide transportation functions for computer data. To a great extent, though, the data communications industry has recently begun to mature to the point that a whole new area of discipline and interest has begun to surface in the last several years, namely, the techniques and procedures to use data communications technology effectively.

I guess I feel that there is an unnecessary amount of mystique in the data communications discipline. Users do need to know a lot about what's going on, but they don't need to become as proficient in data communications technology as someone who designs products.

To a great extent, I think the end users need to adopt a system's view of what data communications is all about. They don't need to worry about the bits and bytes or how the machines perform the functions. They need to view that part of it as a cloud that connects their terminal to their computer and understand what goes on inside there only in a very general way. How does it impact the time it takes to send the messages through the network? What are the economic trade-offs? What are the reliability considerations? What can go wrong and cause messages to come out in a different way than sent?

Not enough users go out of their way to do a few simple things like reading some books and going to a few seminars of a general nature. These things will help them understand in simple terms what is going on between their terminal and the machines they're talking to.

In the same vein, vice-presidents for some major banks have said that they want a telecommunications utility — something they simply plug into the wall. They don't want to be concerned with the details. Is that mood spreading, and how does it affect the telecommunications profession?

The vision of either the telecommunications or data communications utility is one that is as old as the vision of the computer utility. The telecommunications utility is very easy to define, but the technology to actually provide it is not in the marketplace today.

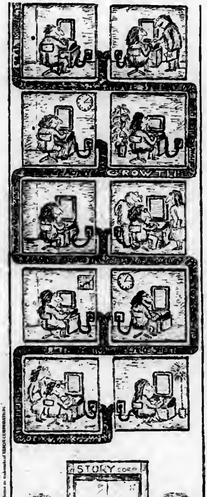
I think those bank vice-presidents are absolutely defining what's required in the future to support their organizations. The biggest barriers, however, are lots of constraints that are imposed upon them in the forms of out-of-date equipment, older PBXs, inadequate wiring of the building, a very definite lack of merging technology in voice/-data integration and the limits and constraints of today's intelligent public data communications networks.

We can see what technology is required to solve a lot of these problems, but as I indicated earlier, there are lots of problems that go all the way back into the computer systems themselves that have stood in the way of coming up with these idealized solutions. I really don't believe that we are going to see quantum breakthroughs in the next two or three years on this front. Only the largest organizations with the most formidable resources will even be able to get very close.

Contrasting the approaches taken by IBM and Bell in marketing data communications, does IBM do more to make the user responsible for technical details of running products and services through a corps of in-house experts? Conversely, does Bell sell data communications as more or a utility — a resource the user can employ without understanding the technical details?

I think that both organizations sell and design their equipment for support of the end user per se. Ask the largest end users of telecommunications and computing whether either vendor does a good job in supporting them, and I think you'll find the answer to be affirmative.

However, what's needed in the marketplace is to a great extent constrained by the need to support an existing line of business, an existing customer base. To give yoo a beautiful example, in a [Dec. 21] *New York Times* article, there's an interview with [IBM Board Chairman] Frank Cary, who



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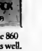

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"Believing that large computers will control office functions flies in the face of what's going on in companies."

states that IBM will definitely not get into the PBX business. We still believe, Cary said, that the office of the future will be controlled by the mainframe. I find that absolutely incredible. Users will certainly have large computer systems in their future, but believing those systems will be the control points over office functions simply flies in the face of what's going on in end user companies today.

You can draw a parallel between that kind of thinking at the executive level within IBM and the kind of thinking that went on at the 13th or 14th floor of General Motors [headquarters] in reaction to the first energy crisis. "Ah, it's not really a problem. Don't worry about it; it'll go away."

That's looking at the world through blinders. Information on the true needs of users is reaching top executives through many layers of bureaucracy filled with yes-men; by the time this intelligence reaches key decision makers, it generally becomes what they think they want to hear.

What do the experts mean when they speak of integrating computer, telecommunications and office automation technologies? When did this integration begin and how is it proceeding?

The integration talked about reflects the fact that to run a business, we need to factor information in the easiest way possible: To store it, to process it and transmit it in very economical and easy ways. The integration phenomenon has only begun to occur in any meaningful way during the past year or two, partly because of the emphasis placed on achieving greater productivity. The typical business now realizes its stake in moving information back and forth. Looking at how inefficient the U.S. Postal Service is, the costs and delays in moving data, you begin to see why businesses recognize enormous potential benefits to be gained by consolidating the functions of transferring various forms of information.

Now, we have to distinguish between an environment in which satellites are available, computers are available and word processing machines are available. In a sense, all these disciplines have existed by themselves for as far back as you can remember. But what's needed is the bridges, the interfaces, the man/machine dialogues and the mechanism allowing for that information to be captured early on in the business where it's generated through user-friendly dialogues at terminals that the masses can use . . .

[We also need] to get away from requiring use of keyboards on terminals and typewriters. Executive resistance to typing is very well-known. So we're talking about the requirements to design software and supporting mechanisms that interface technology to the masses within a business, making it easy for them to use. Also, you cannot forget the need to provide adequate levels of security, control and privacy.

What good will electronic mail be if it takes just a few seconds to move files across the nation by passing signals across satellites, but two days to transfer the information through the mail room to transmitters at the originating end of a satellite link and another three or four days to transfer from receivers through the mail room at the destination end?

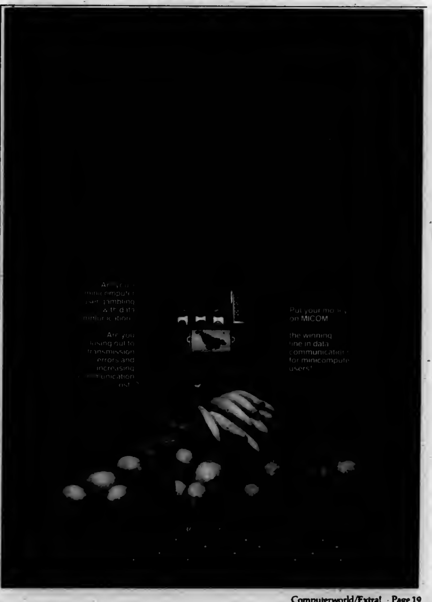
It isn't just technology; it's people requiring a brand of vision in organizations that recognizes a need to impose mind-boggling amounts of change on behavior patterns and life styles within companies that are going to be using these integrated systems. Management at the highest level in these companies must place a premium on people willing to accept change.

Will a number of organizations find they must merge telecommunications and data processing departments?

Unquestionably, they already are. The only ones that have not, in my judgment, are missing the boat or have mitigating political reasons for not wanting to do that. Data processing people depend on telecommunications to do their jobs.

What does the term "management information system" (MIS) mean to you? Is it fair description of this integrated processing of information?

I don't like the term. I think it's too nebulous and open to ambiguity. I recommend that people try to use buzzwords, if they must, that are reasonably well defined. To be sure "distributed processing," for example, is open to lots of different interpretations, but "management information system" is even more vague as a term. Traditionally, it has meant a series of application programs coupled with file structures and possibly data base man-



"There's an incredible need to make processing tools easier for the end user. It's a fantastic business opportunity in the '80s."

agement systems running on a computer that allows varying levels of management within a company access to information they need to run a business. A more current view goes well beyond computer applications and into talking about capturing different types of information and integrating them.

How do we train professional for this new world of integrated DP, telecommunications and office automation?

I've thought a lot about this problem in the last several years. in fact, I think it's one of the most significant problems our industry faces today. I have a lot of friends here [at the University of Michigan] who tell me there are no American graduate students in the engineering disciplines here any more. The computer industry is growing so rapidly that master's degree salaries have gone up into the mid-20s [in thousands of dollars per year] and there's diminishing emphasis on the market for doctoral level graduates. Very likely, our children, if they want to attend a good American university like this, will find themselves in a system that has depleted all its domestic graduates ... That's a terrifying thought.

It's in the corporations' best interest to get this problem solved. They're getting killed by the fact that there are not enough graduate professionals entering the marketplace. They have to chase the salaries up and they find themselves not getting work done; every company has a two-to three-year backlog of applications ... [What's needed] is some very aggressive and significant changes in the way universities structure themselves, such as task forces of executives in the private sector offering assistance to high-level people in charge of professional development.

The Bell System is in a very difficult situation because it has an enormous pool of people highly trained in the circuit-switched technology that is fast going out of favor. IBM is much better off in this respect.

There's also a migration of academics into the private sector. According to an Association for Computing Machinery report that's nearly two years old now [CW, Sept. 17, 1979], there were some 600 vacant computer science professorships in this country. Besides the differential in salaries offered by industry vs. academia, ACM found that a prime reason for the migration was the quality of research facilities; many university facilities were seen as obsolete and unable to support leading-edge projects. Do you see any solution?

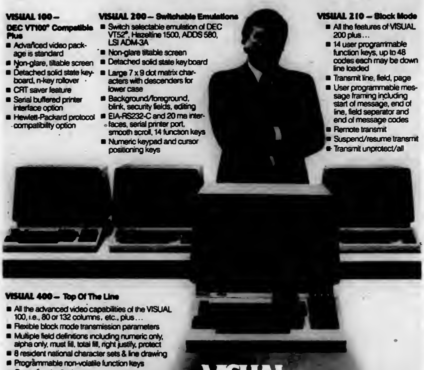
It boils down to an issue that industry must confront: The normal mechanisms for financing higher education, namely, the state taxpayers and student tuition, are going to be inadequate to meet the need industry will have for technical professionals in the 1980s and 1990s.

Some people say that progress in information technology acts to deskill the technology professions. They mean that the proliferation of high-level software, turnkey systems and end-user-oriented equipment , along with the acceptance of approaches to software development such as structured programming that simplify and regiment the process of writing programs, all act to reduce demand for highly skilled user personnel over the long run. What do you think?

In almost any system, or any problem, there's a constant amount of intelligence needed to get the problem solved. In the early days of computing, when there was little in the way of simplifying man-machine dialogues and sophisticated terminals, a high degree of intelligence was required of technical personnel in order to get anything meaningful accomplished. Software is now being developed to ease usage by the masses, but why does this enormous backlog of applications persist? Simply because the needs are changing.

There's an incredible need now for people to make processing tools easier for the end user. There's an enormous gap between the people who know how to design the machines and write the application code and the bridge-building users who can design applications that involve little or no programming in the traditional sense. That's a fantastic business opportunity in the 1980s.

If you look at the software required to control some of the viewdata, Prestel and teletext types of systems for the home, there are very simple man-machine dialogues in there that make



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"In semis, systems and software, America is well ahead of the rest of the world. It may not stay that way, however."

the systems easily employable, but somewhere along the line, complexity has to be provided. Typically, the complexity is in the software that controls the interface between dialogues in the home and data bases of a widely varying nature that people want to access.

Around the time you entered the field of data communications, about 15 years ago, technology was seen in a more sympathetic light by the general public, which marveled at progress toward manned space travel. Since that time, when technology was usually considered a good in itself, many people have grown skeptical, bothered by such technology-driven problems as environmental dangers and the anxieties associated with the nuclear industry. And many view computer technology in particular as a symbol of government, or other powerful political entities, out of control or not responsible to the public. Is this concern justified? What's to be done about it?

Computer technology is just now beginning to have an impact on the lives of the masses. If you look at lots of different kinds of technologies, there's probably no technology that you can identify that, in a pure sense, has more potential power to render socially desireable contributions to all levels with very few potential undesirable side effects. With regard to telecommunications, some governments argue that sophisticated networks are undesirable for their countries; this is especially true in nations where there's a large spread between the Haves and Have-Nots.

I see an attitude developing in America today that says, "Let's take industries in technologies where our country still has a leading position in the world and let's recognize that if we were to lose those [leadership positions], that we'd be making a colossal mistake as a country." In the areas of semiconductors, computer systems and software and so on, the Americans are on balance well ahead of the rest of the world.

It won't stay that way, however, unless we do things to foster continuation of the required research and development and do certain things to improve our tax structure.

But I think that if you were to look at the general public right now, they don't all perceive that information technology does really contribute to the quality of life. Ask the people around here [in the Detroit area] who've worked in the auto industry all their lives whether it would be good for the country to let the same things happen to the computer industry that has happened to the automobile industry. They may not know much about the computer industry, but I'm sure they'd answer with a very definitive and dogmatic "No!"

With regard to government involvement in the computer/communications industry, are you encouraged by recent rulings of the Federal Communications Commission that promote deregulation of what AT&T does in DP?

I'm very encouraged by the procompetitive attitudes coming out of the commission lately

There are lots of legitimate concerns about what AT&T should be permitted to do in data processing. The larger competitors, including IBM, would be pretty comfortable with almost anything AT&T was permitted to do as long as it was forced into a "fully separated" subsidiary. The smaller vendors certainly do have some valid concerns, and I think they will continue to make their concerns known in Washington through trade associations.

In general, Bell recognizes what areas of DP it can enter successfully. I don't think, for example, you'll see Bell enter the plug-compatible mainframe business. It might happen through acquisition [of a plug-compatible vendor], but that would have more undesirable political ramifications than desirable ones for the Bell System.

On the subject of antitrust law prosecution, what do you make of the longest antitrust trial in American history, the U.S. vs. IBM? Would you hazard a prediction as to how the case will come out?

I was personally involved as a witness in the IBM vs. Memorex antitrust trial, so I got an inside glimpse of how such prosecutions go on. What I found absolutely mind-boggling was the day I went into the court room in San Francisco and sat there as the attorneys and the technical experts discussed Winchester and Mallard and

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"The whole issue of terminal-to-terminal communication within the office has been very significantly short-changed by IBM."

double-density disk technology and bus structures and communications front-ends and peripherals to a jury that consisted of a couple of schoolteachers, a truck driver and people who had not even the foggiest idea about the subject matter. They were very honest and well meaning, but this was absolutely ludicrous.

If you look at the history of how every one of the antitrust trials against IBM has come out, there's a strong indication of how the federal case will conclude.

The new pro-business White House may well want to quickly wrap the case up and quit draining the taxpayers' resources. More specifically, I don't think IBM will lose; the company may move to get the case settled out of court. I'm not sure what concessions IBM would be willing to make, but I don't believe there will be a major breakup of the company. There will be some restructuring, but in response to market pressures rather than any antitrust considerations.

However, this is not necessarily true in the federal antitrust case against Bell. I watched the MCI [Communications Corp. antitrust] litigation against Bell, and it appears from reports in the press and elsewhere that Bell has taken measures that are quite anticompetitive and monopolistic. *[Note: MCI was awarded roughly $1.9 billion when one phase of the trial ended in the company's favor late last year. While MCI presses on with the case against Bell, the federal antitrust trial formally began in January and continues in New York — Ed.]*

Notwithstanding Consent Decree problems and antitrust litigation, it would appear that IBM and AT&T are getting into a titanic duel in the data communications marketplace. Will that benefit the user?

On balance, the answer is yes, but the caveat is that neither company can be viewed as the ultimate turnkey solution to all of a user's problems. So long as you have any kind of a business situation where a tremendous installed base of customers requires as much attention as new customers and this is reflected in product lines, then both old and new customers will have problems in getting the service they desire.

Such as?

Well, in the area of PBX technology — which in my view is one of the key mechanisms for controlling the integrated office — IBM's chairman claims IBM won't be going into the PBX business in the U.S. In his position, I would have had a PBX in the marketplace several years ago.

They in fact have a PBX based on the 370 mainframe architecture that is marketed abroad, and several marketing surveys have projected that IBM will offer a PBX domestically...

I'm not so naive as to suggest that you believe everything you read in the papers. But that area is very significant — the whole issue of terminal-to-terminal communication within the office has been really very, very significantly short-changed by IBM. The products for local-networking technology from IBM are nonexistent. There's lots of clamor going on now within IBM, I'm sure, as to what they ought to do regarding an Ethernet answer to some of the coaxial cable bus schemes . . . But it takes a long time to develop answers to those problems and to introduce them in the marketplace as products. The bureaucracy within IBM doesn't make it happen any faster.

That whole area of the integration of word processing, data processing and telecommunications technologies is emerging very slowly with extreme concern over what the implications will be to the installed base. In my view, [IBM's] is not a very aggressive strategy. Now, that could all change within the next couple of years.

Certainly an area of innovation where IBM did recognize a need was when it helped launch Satellite Business System (SBS), which appears to be a very, very desirable service for large corporate America.

All the tariff developments that will occur [in 1981] from AT&T, like the elimination of volume discounts, institution of the usage-sensitive Wats, the private-line restructuring, the turn toward more digital technology and still other developments — if God could have been asked to line up a series of events, including the energy crisis and increased awareness of how much it's really costing people to travel for business, SBS' marketing team could not have planned a more favorable scenario of events.

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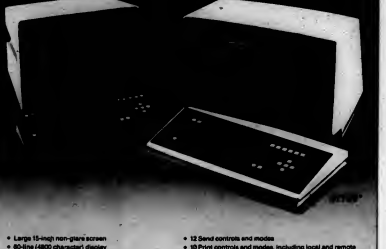

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"There are lots of issues to be resolved in the ISO models that SNA, rightly or wrongly, has already decided."

Just before the launching of the first SBS space vehicle, SBS announced a deal it had struck with Network Systems Corp. that relates to the area of local networks. Network Systems is supposed to build SBS a means of hooking the Hyperchannel, a Network Systems local-net bus claimed capable of 50M bit/sec throughpot, to SBS. Is that a way for IBM to get into local nets, or to accommodate the need for local nets will something have to be done to the basic structure of the Systems Network Architecture (SNA)?

There's a fanatical concern — I don't want to say paranoid — within IBM to maintain the arm's length separation between IBM and SBS, certainly at the customer interface level. I find that it's relatively unlikely that IBM would produce solutions to its local-networking problem by going through the back door — its SBS interest.

The products of Network Systems Corp., as I understand them at this time, are concerned with high-speed computer-to-computer interfaces, [whereas] I've been talking about a need for something that's much more diverse and functionally powerful than a central product that allows you to tie two CPUs together. You have to look at how you're going to integrate text processing with data processing, handle terminal-to-terminal communications, voice communications, document storage and retrieval . . . The only solution from an IBM standpoint is to somehow incorporate that into a significant round of enhancements to its existing SNA product line.

What is meant by the term "open systems interconnection" and what is the significance of the International Standards Organization's (ISO) Open Systems Interconnection reference model?

There is a broad appreciation within the industry of a problem in producing automatic connections of one device to another. There are problems in tying computers to computers, computers to terminals and terminals to terminals. The people who formed the ISO committee that does most of the detail work on the open systems model represent a very diverse group of primarily information processing companies. There are West German companies, American companies and Japanese companies all working together on this. The goal of the model is to define a series of conventions or rules that have to be followed by vendors in order to ease interconnections.

I see a parallel with the early days of air freight transportation. You then had several dozen airlines engaged in the business with nonoverlapping route structures, and sometimes a user would need to move a parcel from, say, San Francisco to southern Germany. He might have to put his parcel in an American plane from San Francisco to New York, then get an American or German carrier to go to the main gateway in Germany, and then possibly get a local German carrier to convey the parcel from there to the ultimate destination. In the absence of standards, you had airlines using different sizes and shapes of containers, different storage protocols within the aircraft itself, nonstandard procedures for instructing intermediary carriers on mode of conveyance . . .

I think that the evolution of the standards has worked into the position where those pretty well agreed upon around the world have already done much to make life easier for terminals and hosts. However, the problems not yet addressed are standardization of high-level machine-to-machine transfers between machines of different vendors. Some doubt remains in my mind as to whether the highest layers of the Open Systems Architecture ever will be completely accepted — let's say agreed upon — and actually implemented in product lines.

I think if you go down to the views in the lower layers that concern transport activity, then you'll have a good chance of seeing some benefit come out of that. I've noticed in my professional career that since this Open Systems model was introduced, it's been a lot easier to explain things to people. If nothing ever comes out of the Open Systems model, one thing that I think it's done of tremendous value is to give people a reference point for separating the functionality that doesn't relate to data communications from that which does. That's a tremendous advantage.

Since the mid-1970s, IBM has promoted the Systems Network Architecture as the foundation of its distributed processing and communications offerings. How does SNA compare to the ISO model?

It is similar in intent in the areas of having divisions of logically independent functions as layers and having rules for the interfaces between those layers. In my mind, SNA is more different from the ISO model than similar to it, however . . . The biggest difference is that it's already implemented and working. There are examples of SNA bugs, but there are software packages [available from independent vendors] that can be run to correct those bugs. Open Systems Architecture — who knows where that is?

One should note the difference between the rules of an architecture and the products that implement it. I'm saying that the rules of SNA had to be there before products could be built to implement those rules. The rules of the Open Systems Architecture, on the other hand, are still being drafted, sent back to the drawing board for comments by the interested parties and so on.

I think there are lots of issues yet to be resolved in the ISO models that SNA, rightly or wrongly, has already decided. I don't agree with a lot of the things reflected in SNA implementations. But [SNA] is there; it's a factor to be reckoned with.

My biggest concern is the general lack of flexibility one has with SNA in positioning networks. I always like to draw an analogy between the spectrum of devices that you can readily interconnect to value-added networks — like a Tymnet or Telenet — vs. those that you can readily interconnect to an SNA transport layer. The lists [of prodocts] are really not comparable.

Critics charge that SNA locks the user into sole-source dependence on IBM and into the master/slave relationship between systems in an SNA network. In fact, Charles Bachman, a distinguished data base expert with Honeywell, Inc., has said that the master/slave concept is "fundamentally wrong" where you have different kinds of systems talking to each other that support different kinds of organizations. While the master/slave relationship and a fairly rigid hierarchy are traditional with SNA, IBM Chief Scientist Lewis Branscomb has frequently said that IBM enthusiastically supports the Open Systems effort and that IBM does intend to support networks supplied by a number of different vendors . . .

Between the time when some vice-president within IBM, who is an extremely powerful and articulate and knowledgeable person, is beginning to look at something like that and the time when you have, as a user, the ability to go out and buy something from IBM that would legitimately address broad interconnectability and that would reflect a considerably new emphasis on peer-to-peer communication or on electronic mail, terminal-to-terminal communications, where you don't have to go through an intermediate primary switching point — you have to measure that interval in terms of years.

If someone were to tell me now that IBM will have that capability in place by 1983 or 1984, I would vigorously question the assertion. The normal reaction within IBM when any user raises legitimate questions, like whether SNA is sufficiently open and flexible, is "Yes, we're working on that problem or we're looking at it." But sometimes the market planners overrule, or sooner or later the problem gets revisited with sufficient emphasis that maybe someone decides to change policy on it.

I heard someone once describe IBM as the Henry Kaiser of the computer industry, meaning that the company behaves as if everything can be made in terms of boxes. If you want to build an airplane, you take a box and put some wings on it; if you want to build

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"It's unlikely IBM will announce support for X.25 in the U.S. until they clearly understand Bell's plans for its ACS."

a house, you take some boxes and put a roof on it; if you want to build a car, you take the same box and put wheels on it — regardless of whether that's what the user wants. There's that kind of a mentality that characterizes product development activities that go on at IBM.

There's a culture within IBM that tends to foster a love of complexity for its own sake — which is one of their biggest problems You see that in JCL and all the operating systems. That kind of a mentality — of begrudgingly admitting that the end user is ultimately going to take control of the situation — is one of the most critical threats to IBM's business that the company will face over the next several years.

Closely related to this is the imminent demise of the corporate vice-president for MIS . . . unless [MIS managers] also take this view of what's really happening. Can you pass a rule in an organization that people can't use Apple [Computer, Inc.] personal computers, for example? Should you? I know of some companies that have passed rules saying you can't buy Apples if you're an engineer. So you know what people do? They go out and buy them themselves! Spend their own money on an Apple computer in order to get their programming done because [Apples] are so much better at getting the job done than some of the dumb terminals and time-sharing systems that would otherwise have to be used.

In this country, at least, IBM's SNA does not meet the three layers of the ISO Open Systems model that have been defined thus far: X.21, HDLC and X.25. That's been the focus of a certain controversy lately. Why?

I'll answer that question with a question. Why should SNA's first three layers in the U.S. adhere to the first three layers of the Open Systems Architecture? The answer is that there's no network in place of any real significance in the U.S. today — that is, for a company worth at least $50 million — that requires IBM to adhere to the ISO standards. It's unlikely that IBM will make any announcements about how they would support X.25 in the United States until they have a very clear understanding of what the Bell System plans for its Advanced Communications Service.

If I were in IBM's position, I'd be structuring my product line to be much more standardized so that when X.25 networks suddenly emerge [in the U.S.], I'm not going to have to go back to the drawing boards. The best illustration of what should be done is the direction Honeywell recently announced, where they've indicated that their transport functions will be provided in any configuration that involves Honeywell DP machines and either public or private networks. The basic transport functionality is going to be the same [in all cases]. The only differences will be the boundaries between the functions provided by Honeywell and those provided by public carriers.

Major public packet nets like Telenet, Tymnet and Canada's Datapac do comply with X.25, and I'm told by experts that many problems arise in trying to plug SNA networks into the public packets. It does seem to be a problem for users.

Well, I just came back from Europe, and over there IBM is already forced to provide SNA to X.25 conversions. Fundamentally, IBM has introduced a solution for X.25 to SNA interfaces in several European countries as well as Japan.

The approach that's been taken is to build a black box that makes [X.25] terminals appear as IBM terminals to IBM's 3705 [communications controller]. The problems with fitting a black box or software SNA-to-X.25 converters are simply problems of overhead, the subtleties of higher level protocols that go back and forth on the end-to-end acknowledgments and the costs that one has to incur in taking that approach. The interfacing approach announced by IBM in some of these [foreign] countries restricts itself to a level of communication between a mechanism that's emulating a cluster controller and one of the higher level modes of SNA.

Let's say you have a host [with] two 3705s and a link directly between them, and you want to replace that link with a public network. You cannot do that today and [users] admit that's a reqoirement, while IBM has told me "Yes, we're looking at that." So the idea of replacing a link between two 3705s with a direct X.25 communication is a very real requirement IBM does not meet.

Would you be surprised if IBM announced some means of fitting SNA to

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X.25 within the U.S. in 1981?

The only demand in the U.S. right now [for X.25] is by multinational corporations. I think there are a few internal users within General Telephone & Electronics that would like to go 3270 SNA on Telenet . . . but you will talk to the market planners and you will find they cannot find thousands of corporations that are demanding that product.

The issue here is basically whether IBM is ever going to break its traditional hold over the network. Is it going to be willing to say to a user, "Yeah, you can go out and get your function from the public data network or you can get it from us; we don't care which?"

In the short term, I see no reason to believe that IBM is changing its thinking about being very conservative and very meticulous in terms of opening up some of these networking functions and making it easy for the customer to get those networking functions from someplace else.

I was in a meeting recently where a person indicated that the mentality of SNA is such that if IBM had been given the responsibility for building the public telephone network and had used the same philosophy as SNA, then all the subscribers would have to hang up before a new telephone could be installed.

They absolutely blew It with SNA when they chose the lowest layer to be SDLC and did not pay attention to the possibility that some day you might need to come in and address down to the modem level, or to take that physical link and the modem combination and be able to further address and divide that up. What they've done on the latest diagnostic modems is [require you] to send special commands down the link to the terminal controller or the modem, where you use the same address as for the terminal itself, but because it's a question of command, the modem's microprocessor will recognize a deviant address. They have a horrendous strategy now of letting you develop remote diagnostics in a two- or three-N-stage network because if you send messages out, they've got to be recognized by the appropriate node in the network, but in effect all this addressing is now being done down at the link level. So you've got to come up with a whole new overlay — in terms of the address space — to get out there to some of the downline points.

We've had some clients that have been in to see IBM, and IBM's given them all the lip service, "Yeah, we're working on that problem," but the solutions [from IBM] are not acceptable. IBM's answer is always going to be to come up with another layer of software that will run on a machine like the 8100 to perform that function of passing a command on through. Well, the last thing users want is more software that's going to consume very, very precious cycles in an 8100. Secondly, they don't want a solution that requires the network control channels to have to pass through the DP machines. What happens if that 8100 is down?

So there's this basic mentality at IBM that has never come to grips with requirements a user really has to put together a physical network that's independent of the application processors that are connected to it.

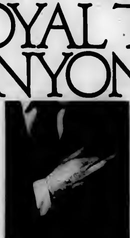
Here's a nice fundamental question. What is packet switching? Where did it come from and where is it going?

It's sending information in chunks. People do packet switching in some sense of the term when they send magnetic tapes. If, in a shared-user network, there are lots of users and the behavior of any one of them can have an adverse effect on performance of the rest, packet switching takes the approach of . . . "All right, if we have a user with a very long message that would otherwise tie up the system, we'll chop his user message into little small pieces and interleave these pieces and use those as the things we spray through the network. When we get to the end and recognize a long user message, then we reassemble the packets and deliver the message to the ultimate destination."

For years, there's been a concern on my part that packet switching has a very definite role to play in the future of data communications. But I think that packet switching is by no means the answer to the maiden's prayer. It does not provide really satisfactory performance under all kinds of traffic conditions.

What conditions?

Well, let's back up and ask, "Under what conditions is packet switching beneficial?" Any time when you have a terminal user sitting at a keyboard



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and composing messages and then sending them through the network, you'll find that his overall usage ranges from something like 5% or 10% to 25% or 30% because of the think time that goes on, the keying differentials between the user and the network links and so forth. That speed differential means that if you're operating in any kind of buffered environment where you're composing a line of text and sending it through the network, the demand for capacity that that user has is going to fluctuate from trunk to trunk.

All studies of packet switching indicate that packet switching [is most beneficial] where the traffic is very, very statistical in nature — the messages arrive in pretty much an uncorrelated manner between different users and when they arrive they don't place prolonged demand on the network for continuous amounts of capacity. And it's that latter kind of traffic, when it comes into the packet network — the way the packet network treats that is to start chopping up these long messages and so what you end up with is a steady requirement for a flow of packets between two places in a network. That predictability — that requirement for continuous capacity regardless of [mode of transmission, packet or otherwise] — tends to begin to show up in the behavior of other users.

Today's packet networks cannot deliver the performance of leased lines, but not every interactive netword needs the 1.5- to 2-second response times leased lines can deliver. When response time needs are on the order of 5, 6 or 8 seconds, then packet switching can provide . . . solutions. But then, there's the economics to consider.

Where's packet switching going from here?

It's in a stage right now where the nodal machines that perform the packet switching — for Tymnet and Telenet as examples — tend to run out of gas or die or whatever. Their capacity limit is up in the range of 56K bit/-sec. What we clearly need if we're going to solve these delay problems on an end-to-end basis . . . is the ability for packet-switching nodes to operate across links at much higher speeds than 56K bit/sec.. T1 carrier lines are needed at 1.5M bit/sec.

Problem is, can some users plug into 1.5M bit/sec links? Many can't right now although they'd like the capability.

On the subject of data communications speeds, the technology is supposed to give the world orders of magnitude increases in available speeds during the next several years. Do users need to pass data that much more rapidly? It depends on the application. In the area of bulk data transmission, the present speeds are bordering on being inadequate if they're not already, but there's probably no need for higher speeds in the area of interactive applications . . . You're not going to see interactive CRT terminals running at 56K bit/sec.

But you are going to need these much higher throughputs where data and voice are integrated along with word processing.

What is Bell's Advanced Communications Service?

It's been pretty much in limbo during the past year. There are something like 100 people in AT&T working on the technical specifications. Fundamentally, it's designed to be an intelligent network primarily addressed to administrative message communications and electronic mail. It will have file storage for mail box activities. The user will be able to design his own dialogues. Unquestionably, it will involve much of what we call data processing today.

What is Xerox Corp.'s Xerox Telecommunications Network (Xten)? What problems is Xerox facing in getting this service out to the user?

The business concept of an Xten network is an absolutely superb idea. No question about that.

One of the things fundamentally different between Xten and ACS is that Xten is going to include a considerable amount of noncoded information support right from the start for things like its facsimile products, whereas the ACS primarily [calls for] coded terminals and that kind of thing.

The whole idea in Xerox's philosophy for Xten is document transmission as well as data communications in slow-speed teleconferencing. They encountered a series of problems . . . The biggest is the politics of a large organization in which a network of the [scale] they are undertaking is such a big project that they began to tool up

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"The security problem is very real. It's of paramount importance to anyone who intends to use any kind of network."

for this thing and some of the people [within Xerox] being asked to approve some of these plans did so at the beginning without really understanding what they were signing off on. And by the time they got in, to the tune of a couple of hundred million dollars, and saw where this thing was going and what the maximum negative cash flow was likely to be under some pessimistic scenarios — some people in top management said, "Hey, wait a cotton-pickin' minute here, things are getting out of control; we can't have a plan that is an all or nothing thing where we have to put in a billion dollars before the thing is going to be viable."

So, my judgment is that they began to look at the total investment requirements. I don't think there's any doubt that . . . the potential is there. One can't criticize that. But the likelihood of them reaching various levels of penetration, given the number of technology problems in the local distribution area . . . the sheer logistics of putting many earth stations into place to support their metropolitan operations — that's tremendously time-consuming. It's a regulatory process that's fraught with uncertainty.

So Xerox is going through a painful process of mapping Xten back into something that's realistic and that they can explain to their shareholders in a way that it won't appear like another Scientific Data Systems venture or RCA into the computer business.

It seems a sure bet that data networks in coming years will be far more powerful, but will they be adequately reliable and secure? Will the added complexity, interconnection and brute force of tomorrow's data networks make outages, malfunctions and security breaches far more costly to the user and society as a whole?

I feel that the security problem is very real. I think that it's absolutely of paramount importance to any customer who is looking at using any network . . . to make security totally his responsibility. I think that he can expect little or no practical help from the vendors of these systems. The whole concept of saying, "I'm going to use a public network and obtain the encryption functions from the public network and vendors" — that's a contradiction in terms!

From a plain technical point of view, I don't think reliability will be the problem with future networks that it is today. There are a few reliability and throughput problems on networks today.

So they're as reliable as networks of their type can be, given the current state of technology?

I think that's a fair statement. But there's a lot of new technology that can be brought to bear — for example, most of the packet-switching nodes that have most of their key components fully redundant. I'm really thinking of such problems that happen when your access lines go down. Those are your real practical problems that a lot of people have really not come to grips with yet. Those access lines from those networks into your hosts and your data bases where all the information is stored — those are critical; they're just as naked as your front-end processor . . .

Some of those answers will lie in the oltra-smart PBXs that are going to do super least-cost routing so that when the customer's front-end processor senses a failure in access to some network, another route to the network can be found. But that technology is not being utilized very much, so there's another wave of significant technology that can address some of these reliability and performance problems.

How does stagflation affect the management of data communications?

Well, it makes companies unwilling to spend money on training and on educating their people. It puts more and more emphasis on the short-term profitability of a business. It does all the wrong things in terms of impeding the efforts that need to be done. To turn that around, now [stagflation] also puts pressure on organizations to come up with ways to increase their overall productivity. So the good of that whole question is a technology that is very productivity-intensive. There's a lot of leverage in doing something based in the data communications area.

Most data communications of a typical, geographically distributed user occurs at the local level. Should local networks be the focus of concern for network planners?

The focus should be on looking at all the corporation's requirements for information transfer. What may be a local requirement today may not be a local requirement tomorrow. The purpose of networks in general should be to mask geography. It's that simple. And they can mask geography by creating a bridge between somebody that lives on one side of Los Angeles and his corporate headquarters on the other side of town so that he can work at home for a day or two per week.

What scares you the most about the future of data communications?

I guess the thing that scares me the most as a representative of the industry is the enormous demand for the people vs. what I see happening in supply.

That problem creates opportunities for me in my consulting firm because I collect levels of expertise in different problems and I open offices in the major places like the [San Francisco] Bay Area and New York and here in the Midwest and in other areas, and I can provide solutions to other companies that have that problem.

If you ask me what scares me the most as simply an individual in society, not letting my answer be colored by business opportunity, the great concern I have is over undue influence and abuses of power creeping their way into the industry in the form of either unfair competition or abusive monopoly practices by large organizations or meddling in our industry by governments.

It's amazing to go to Europe and see what they're actually going to have in their network vs. what they could have if there were some type of an open and free environment. The opportunities that those within those countries are going to have is going to be so packaged and so controlled and so limited to what the government thinks is best for them that it's very sad. It's scary when you think about the people who are making a lot of these decisions about where universities go and what kind of government regulations . . . These people are making very basic, fundamental decisions on the basis of experience and intelligence that is extremely limited at best. And they have no vision of what the technology's about, how it should be used, what its impacts are going to be — yet they are the ones setting the policies . . .

In the U.S., go down to the local public service commissions in the states and you'll see very, very close examples of what I'm talking about. I always used to wonder about what happened to people who graduated in the bottom third of their law school graduating class. Then I got involved in some rate proceedings at one time and found that they all go to work for the Bell System in the local operating companies to beat the public service commissions over the head.

Now the flip side of the coin: What gives the most cause for optimism?

We have technology that offers a very real possibility for immediately changing the way we live, the way we do business, in a very positive way. For example, I absolutely love to think of the day when I'm going to be able to carry on some of my meetings and some of my transactions without having to get on airplanes by being able to get onto nearby teleconferencing studios. The prospect of being able to access lots of information; to play with my home computer and do many of the kinds of things that I need to do in order to run my business better; and to do those over networks where I'll be able to communicate with people in my office by terminal from wherever I want to be — these, I think, hold some incredible possibilities.

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By Gerald W. Williams

FOCUS ON DATA TERMINAL EQUIPMENT

Selecting a data terminal for a communications-based system can be a difficult task. Along with such obvious technical considerations as interfaces, data transfer rates and compatibility, the selection process requires an analysis of individual business needs and human factors. All three elements must be examined before the proper terminal can be selected.

The wide selection of terminals further complicates the process. Depending on the applications, a general-purpose application-specific or special-purpose terminal may be required. General-purpose terminals include teleprinters, alphanumeric display, intelligent display and remote batch terminals. Such equipment as optical character recognition systems, computer output microfilm and bar-code scanning systems are categorized as being applications-specific. Special-purpose terminals include data collection systems, automated teller terminals and point-of-sale systems. For the purpose of this report, we will focus on general-purpose terminals because of their versatility and popularity.

The most basic terminal is the teleprinter. Teleprinters were originally designed as a communications device for telegraph networks. As such, they are generally compatible with most public communications networks, and these terminals have become the most widely used communications device for data processing networks.

Three standard configurations of teleprinters are available. They are the receive only (RO), keyboard send/receive (KSR), and automatic send/receive (ASR) configurations. An RO teleprinter consists of only a printer and is used for central-computer-to-site broadcast applications such as message dissemination. KSR teleprinters include a keyboard and a printer and allow bidirectional communications. The ASR configuration provides auxiliary storage equipment, which supports operation of the teleprinter without user intervention.

The basic teleprinter, however, is limited by two factors. The first concerns the user. Teleprinters, because they are based on a mechanical printing process a majority of the time, tend to be noisy. High noise-level can obviously eliminate the teleprinter from consideration in certain business environments. Additionally, the typical teleprinter operates at a print speed of approximately 30 char./sec. In many cases, this speed is not sufficient for interactive applications.

Some teleprinters have been enhanced beyond the traditional definitions and operate at higher rates of speed and support more applications.

It should be noted, however, that the cost of the unit increases as the capabilities are enhanced. Therefore, a teleprinter may be the technically proper terminal for a communications-based system, but it may fall short in the area of cost or efficiency.

In contrast to the interactive nature of teleprinters, remote batch terminals provide a cost-efficient method of providing remote sites with access to centralized processing power.

The basic concept behind remote batch processing is that the terminal accumulates a certain amount of data and then transmits that data, as a whole, to the host computer at high speeds. The computer also sends information to the terminal in the same batch mode. Whereas teleprinters are typically used to transmit short messages at a comparatively low rate of speed, the remote batch terminal allows a user to utilize communications lines more efficiently. The remote batch terminal, however, does not support interactive communications between the user and the central computer.

Remote batch terminals are generally configured with a terminal controller, an operator control panel/console, an input device and an output device. The output device (usually a printer) is typically packaged separately from the other elements of the terminal. The input device can be an electronic keyboard with an alphanumeric display, a teleprinter or a card reader.

CRT Terminals

Alphanumeric display terminals (or CRTs) are tha most popular form of interactive terminal in use today. These terminals include a keyboard for sending information and a display unit, which provides the user with a visual means of reviewing data he has sent or for receiving data.

These terminals can also support a printing station for hard-copy output in some cases. As mentioned earlier, however, a mechanical printer (in contrast to a thermal printer) may create an unacceptable noise level.

Selecting an alphanumeric terminal can involve more factors than have been mentioned previously. Such elements as the size of the display screen, the capacity of the display and the format of the displayed characters are fairly standard, but choices do exist. The most important consideration on screen size and character formation is user comfort. The display must be readable and should (physically) fit well in the working environment.

The majority of alphanumeric terminals display a maximum of 1,920 characters (24 lines of 80 characters each) at one time. There are, of course, smaller and larger versions offered commercially.

A technique that can artificially increase the display capacity is called paging or scrolling. This feature is offered on several terminals and allows users to flip through lines or fields of data that are held in a buffer.

Other features commonly supported on alphanumeric terminals include:

- *Reverse video.* This feature presents a negative image of the data being displayed (i.e., a character normally displayed as light on a dark background will appear dark on a light background) on the screen. Reverse video can be applied to a single character, a line or the entire display.
- *Insert/delete capability.* This capability allows users to delete a character, field or line and/or replace that data with more accurate information.
- *Split-screen display.* This feature supports the simultaneous display of varied sizes of characters. Additionally, some manufacturers offer a split-screen capability that allows the user to display different formats on the same screen.

The flexibility of alphanumeric terminals and their interactive nature have made them a popular choice of terminal for a communications-based system. It should be noted, however,

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Gerald W. Williams is a product manager with Auerbach Publishers, Inc., Pennsauken, N.J.

> **"Once a user has determined the class of terminal he requires, he must create a list of mandatory and desired specs."**

that these terminals do not provide hard-copy output. In most cases, this problem can be resolved by attaching a printer to the terminal, but this entails additional cost.

Intelligent display terminals were an outgrowth of the alphanumeric displays. With the advent of microprocessors and the decrease in the cost of computing, it was only natural to place some processing power at the user's site. The flexibility of an intelligent display terminal allows it to be programmed to perform any of the functions detailed earlier. As the level of flexibility has increased, however, so has the cost of the terminal.

Intelligent terminals are similar in appearance to alphanumeric terminals. In addition to the capabilities of alphanumeric terminals, the intelligent terminal can often perform data and text editing tasks, support high-level languages and perform data validation routines as well as run applications programs. These capabilities, in some cases, will decrease communications costs, because the terminal does not rely on the central computer for all its information and processing power.

Additionally, intelligent terminals can support peripherals for auxiliary storage and printing. Another feature of intelligent terminals is the inclusion (by some manufacturers) of programmable function keys. Using these keys, the operator/user can easily initiate a new task or function, perform data validation routines, retransmit screens to the central computer or perform other similar programs.

Intelligent terminals are more expensive than the average terminal that has been discussed to this point. The decision process must, therefore, center on the issue of cost vs. utility and flexibility.

Up to this point, we have been more concerned with identifying the functions which each class of terminal can support. Once a user has determined the class of terminal required, he must create a list of mandatory and desirable specifications.

Some of the areas that need to be addressed in the selection process include cost, vendor reputation, equipment reliability, vendor experience in the specific application, ease of operation, maintenance, physical size, availability and technical support.

Cost of the terminal should be extended beyond the simple purchase, lease or rental fee. Such elements of expense such as on-going maintenance fees and the cost of not using a terminal should also be factored into the final figure.

The following items should be investigated in regards to the vendor's reputation:

- The length of time that the vendor has been involved in the data processing industry.
- Other data processing products offered by the vendor.
- Quality of technical and maintenance support offered by the vendor.
- Financial condition of the vendor.

Equipment reliability must also be determined. Areas of interest to the potential buyer should be the technology used in the terminal's manufacturing and the vendor's warranty policy. Solid-state and components using large-scale integration will have fewer failures than older technologies. In addition, it may be helpful if the mean time between failure can be determined.

The vendor and his claims of terminal performance should be validated through interviews and visits to sites that are using the vendor's terminals. These sites can be determined through the vendor. Additional interviews should be undertaken with sites other than those listed by the vendor. These should be local

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794-558

"The user should never lose sight of the fact that the terminal is being considered as a solution to a business problem."

companies that use data processing to perform functions similar to those the potential user is planning. It is not vital that the same vendor or equipment be used in these situations. Rather, the other businesses will allow a potential user to examine options to his plan of action.

Human concerns are addressed by investigating the ease of operation that the terminal offers. Such areas as follow should be investigated:

- The keyboard should be configured in the familiar correspondence or teletype format.
- Nonglare surface should be provided on the display.
- The unit should fit comfortably in the available work space without crowding the operator.
- The functional components of the keyboard and display should reflect concern for the user's comfort.

Finally, the delivery schedule, technical support and maintenance policy should be determined.

Once all the elements discussed in this article have been identified, the choice of terminals should be narrowed. The final decision can then be based on common sense, knowledge of the business and system requirements and understanding of the particular applications.

The user should never lose sight of the fact that the terminal is being considered as a solution to a business problem. Use of these elements allows the user to select a terminal with a high rate of success. ◆

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T **Ahearn & Soper**
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T,A **Anderson Jacobson, Inc.**
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(408) 263-8520

A **Ann Arbor Terminals, Inc.**
6175 Jackson Road
Ann Arbor, Mich. 48103
(313) 663-8000

A,I **Applied Digital Data Systems, Inc.**
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(516) 231-5400

T **Bedford Computer Systems, Inc.**
3 Preston Court
Bedford, Mass. 01730
(617) 275-0870

A **Beehive International, Inc.**
4910 Amelia Earhart Drive
Salt Lake City, Utah 84125
(801) 355-6000/
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A,I **Bunker-Ramo Corp.**
Information Systems Division
35 Nutmeg Drive
Trumbull, Conn. 06609
(203) 377-4141

A,I, R,T **Burroughs Corp.**
1 Burroughs Place
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(313) 972-7000

T **Carterfone Communications**
Suite 1400
1111 Mockingbird Lane
Dallas, Texas 75247
(214) 630-9700

T **Centronics Data Computer Corp.**
1 Wall St.
Hudson, N.H. 03051
(603) 883-0111

R **CMC Pertec**
12910 Culver Blvd.
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(213) 822-9914

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(312) 677-3900

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Berkshire Industrial Park
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(203) 744-6720

A **Computer Peripheral Corp.**
1225 Connecticut Ave.
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(203) 333-8339
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A **Conrac Corp.**
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(212) 754-0680

I,T **Data Terminals and Communications, Inc.**
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Campbell, Calif 95008
(408) 378-1112

A,I **Decision Data Computer Corp.**
100 Witmer Road
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(215) 874-3300

A **Delta Data Systems Corp.**
Woodhaven Industrial Park
Cornwells Heights, Pa. 19020
(215) 639-9400

T **Diablo Systems, Inc.**
24500 Industrial Blvd
Hayward, Calif. 94545
(415) 786-5000

T **DI/AN Controls**
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Boston, Mass. 02125
(617) 288-7700

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(215) 872-0800

A,I,T **Digital Equipment Corp.**
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Maynard, Mass. 01754
(617) 897-5111

T **DMC**
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2300 Owen St.
Santa Clara, Calif. 95051
(408) 249-1111

A **Electronic Engineering of California (EECO)**
1441 E. Chestnut St.
Santa Ana, Calif. 92701
(714) 835-6000

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3005 MacArthur Blvd.
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(312) 291-2500

I,R **Four-Phase Systems, Inc.**
10700 N. DeAnza Blvd.
Cupertino, Calif. 95014
(408) 255-0900

T **General Electric Co.**
Data Communications Products Division
Waynesboro, Va. 22980
(703) 949-1000

A **GTE Information Systems**
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Stamford, Conn. 06940
(203) 357-2000

I,R,T **Harris Corp.**
Data Communications Division
16001 Dallas Pkwy.
P.O. Box 400010
Dallas, Texas 75240
(214) 386-2000

A **Hazeltine Corp.**
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(516) 261-7000

R **Hetra**
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A,I **Hewlett-Packard Co.**
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Cupertino, Calif. 95014
(408) 257-7000

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A,I,R **ICL, Inc.**
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A,T **Intertec**
Datacommunications Division
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A **ITT Courier Terminal Systems, Inc.**
1515 W 14th St.
Tempe, Ariz 85281
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A,I **Lear Siegler, Inc.**
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Anaheim, Calif 92803
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U.S. Division
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Irvine, Calif. 92714
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I,R **Mohawk Data Sciences Corp.**
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By Dean Gillette

TELEMATICS:

THE INTEGRATION OF COMPUTING AND COMMUNICATIONS

The revolution in telecommunications today is as much a change in the basic nature of telecommunications as it is in technology.

For telecommunications itself, we need only two functions: a transducer and a transmission line. Transducers are things that convert energy from one form to another, and a transmission line connects them. A metal membrane converts voice pressure waves to a mechanical vibration or vice versa, and a taut string transmits vibrations. Thus, two cans and a string are a telecommunications link that works for a few feet.

For greater distances, transducers create electric signals that are transmitted over a pair of wires or a coaxial cable or relayed as a radio signal. A telephone is an electrical transducer, so is a television camera or a television display or a facsimile system.

For a telecommunications *network* we need to add switching as a third technique to combine with transducers and transmission. Without switching, each transducer would have to be connected with each other by a dedicated transmission line. Simple combinatorial analysis shows that the number of connections needed so each transducer can be linked with each of the others increases as the square of the number of transducers.

To avoid this tyranny of numbers, each transducer is wired to a local switching office where connections are made, on demand, between the transmission lines linked to each of the transducers.

Tough Task

There are some 20,000 local switching offices in the nation, counting both Bell and independent companies. To connect all of these together directly would require 200 million trunks, and to avoid that magnitude of transmission, the telephone network includes a hierarchy of switching machines to switch the trunks between the local offices.

The result: Instead of having 200 million interconnecting trunks, there are something like 10 million in the network.

In its first 80 years, the telecommunications network simply interconnected people-oriented transducers: telephones, TV cameras, FAX machines and so on. The real revolution started when remote access to computers began shortly after World War II in sophisticated national air defense systems and, later, in the worldwide ground systems that supported manned space flight. Both of these networks linked computers as well as people.

Data processing *in* communications has been with us almost from the beginning. Switching systems use it in selecting a desired connection in response to called number information dialed by telephone users. Paper-tape Teletype machines had a substantial text-editing capability that permitted review and correction of prepared information before subsequent transmission.

Directory assistance is clearly an information retrieval function which is accessed over a telephone line. With the newer technologies, we can replace relays in switching systems, paper-tape data storage and some operator assistance functions with stored program control machines, but that is just increase of capability and productivity *within* telecommunications as a result of applying new technology.

Integration of computing and communications has brought us something new: access to sophisticated DP systems *through* telecommunications. It allows people to communicate with machines at a distance and to carry out DP that has no relationship to telecommunications. It links stored program controlled machines with others so that data can be exchanged.

The combination of techniques al-

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"There are four driving forces in telematics: chips, computing, optical fibers and communications satellites."

lows introduction of new services which we constantly read about: electronic fonds transfer, electronic mail delivery, national crime information systems, the automated office of the future and library search and information retrieval systems.

New Concept, New Name

Such a new concept needs a new name. Oettinger at Harvard calls it "compunications" to reflect the combination of computing and communications. The French have coined the word "telematique" as a combination of their words for automatic control and telecommunications. And the English have adopted the anglicized form "telematics." I prefer the last and use "telematics" to identify systems which contain automatic DP that can serve other than telecommunications functiona, along with the transducers, transmission and switching that have made up conventional telecommunications networks.

Not only are telecommunications and computers the two elements of telematica, they also share common technology bases. And it is progress in these technologies that will open even greater opportunities for future applications.

As I see it, there are four driving technologies in telematics: first, solid-state technology; second, computing, particularly in the form of stored program control of automatic operations which includes arithmetic, machine control, information storage and retrieval; third, guided lightwave transmission, or optical fiber systems; and fourth,.communications satellites. Let us look at these in some detail, taking them in reverse order.

Superb Technology

Communications satellites are a superb technology for distributing television signals. They have the advantage of accepting a TV signal sent from one point and, with a nation-spanning antenna pattern, distributing that signal from one source to antennas across the entire U.S.

This service is currently being used with receivers at the head end of community antenna television systems and, in a plan proposed by Comsat and others, may be complemented by receivers from the rooftops of homes or apartment houses. Again, because communications satellites are readily visible from many parts of the world, they are well located for relaying signals from one continent to another. Indeed, they are the only means today for transmitting television signals in real-time across the oceans.

Within the U.S., though, such terrestrial communications systems as microwave radio relay, carrier system on wire pairs and coaxial cables provide a distinctly competitive alternative to communications satellites for distribution of many types of point-to-point communications, particularly telephony.

Fiber Optics

In the future, optical fiber communications may provide an even more efficient terrestrial technology where the calling capacity requirements are great.

Optical fiber communications are those in which communication signals are converted into pulses of light carried over hair-thin glass fibers for miles before accumulated attenuation and distortion need be removed by electronics. Systems based on this technology are now commercially available in some parts of the telephone and television plant, and as the 1980s progress, there will be more extensive application of the technology.

For instance, AT&T has a plan to instal an optical fiber cable on a route between Boston and Washington, D.C. It initially would have the capability of carrying some 40,000 two-way voice conversations and, as demand increases, can be readily upgraded to twice that. At Bell Laboratories, we are currently investigating optical fibers as a base of a submarine cable system which conceivably could be laid across the Atlantic in the late '80s.

Because optical fibers are capable of carrying television as well as telephone signals, a submarine cable optical fiber system running from the U.S. to Europe would provide a competitive alternative to satellites for television as well as telephony and data. Here again, we see an instance in which terrestrial facilities serving high-capacity routes may be more efficient than satellites.

We can also readily imagine optical fibers connecting to homes and offices throughout the nation as do paira of wires now. It will be technically possible to have optical fiber connections to home information systems for transmission of television, information retrieval services and high-speed facsimile systems as well as telephone. Experiments with such applications are found worldwide — in Canada and Japan, for example. The open questions for analysis concern costs and markets.

Computing Technology

The third technology that I mentioned was computing. I think this should be regarded as a *technology* instead of an art or science because it is an essential ingredient in atored program control systems, either within the telecommunications network or within the adjuncts that change telecommunications into telematics. The "programming" part of computing is an activity that is comparable to manufacturing of hardware. It must be preceded by thorough systems engineering and project planning, complemented by tight project management and followed by installation and maintenance.

The installation phase may be expenaive: transformation of a paper-based manual record system into a computer-based automatic record system may cost millions of dollars simply for reformatting the information. And neophytes in the computing, or software, business may forget to plan for system maintenance. Data bases, computing algorithms, information retrieval logic and the like are all subject to change and improvement. It is necessary from the beginning to anticipate carrying out the changes in the software system which are the equivalent of physical maintenance of hardware systems.

The fourth technology I mentioned is solid-atate electronics. It emerged as a dominant concept over 30 years ago with the invention of the transistor and has since grown to have a tremendously wide variety of opportunities for application. Solid-state electronic devices, no matter what form they take, may be thought of as club sandwiches of exotic materials placed down in precisely controlled layers. These layers may be of materials of carefully controlled impurities. Careful attention to matches between crystal structures may be needed at layer surfaces. The layers also have precisely controlled physical shapes as well as electronic properties. To meet these demanding requirements, we have developed manufacturing processes with names like "zone melting," "molecular beam epitaxy" and "electron beam exposure systems." With them, progress in solid-state electronics has indeed been extraordinary.

In 1960 the first of the "integrated circuits" was built, and it contained several active elements with transistor elements connected by thin strips of metal, all laid down as a part of the same manofacturing process. Since 1960 the number of elements that could be laid down on a single piece, or "chip," of silicon the size of your thumbnail has been doubling each year, so that today the state of the art is auch that 100,000 active elements can be built all at one time on a single chip of silicon.

The size of the active elements and the interconnecting conducting layers and the apacing between them is now approaching dimensions of one micron — one millionth of a meter. This precision ia the characteristic of large-scale integration (LSI). In laboratories today there are experimental approaches being made to make even amaller elements with greater compaction. With this "very large-scale integration" (VLSI), we believe the doubling of densities that I mentioned can continue through the 1980s, and a million active elements per chip is a possibility. The point is that the power of solid-state electronics technology will continue to grow in the 1980s.

Home Aspects

Solid-state electronic devices and computing are common bases for all aspects of telematics. The newest switching machines in telecommunications have stored program control, as do modern computers. With solid-state electronics we have been able to reduce costs in all parts of the transmission plant, both that for long distance and for local telecommunications. As we move into the 1980s, we will see microprocessors being incorporated in terminal equipment in homes and offices to give us all greater flexibility in managing our business and lives.

We all read a lot about the automated office of the future, in which computer systems replace files of paper records. The new technology will also affect our home lives.

Suppose, for example, that you have been away from home on a trip and like a good citizen have kept your furnace turned down to save energy. Today you come in and turn up the heat and shiver ontil the house is warm. In the future you might have a home information system, complete with microprocessors, that connects to your telephone and to your furnace. Half an hour away from home on your return trip you would dial your own telephone number and with the punch of a few buttons cause the furnace to come on so that your house would be warm when you arrive.

Information Access

To complement such internal logics as I have described would be the growing opportunities for business and personal access to information of all kinds. Two examples are illustrative. A teletext service is one in which data is sent along with a television picture in broadcast. With a properly adapted television set, the text could be shown on an unused channel or it might be shown as English aubtitles under a motion pictore for reading by the deaf.

Videotext is the term currently used for transmission of information over a telephone line for display on the home television set. In the British version, originally called Viewdata and now Prestel, the subscriber dials a central computer requesting information. The computer response is transmitted over the telephone line and stored temporarily in a device at the subscriber'a premises. The device, which is connected both to the telephone and to the television set, generates a television picture much as do TV games. The accessible information might be store sales advertising, guidance on spraying for farmers or even stock market quotations.

Experiments with such systems are going on throughout the world and exemplify the new kinds of personal services available with telematics.

Service Improvements

As well as helping wed computing and communications into new telematics services, the dominant technologies are being used to improve basic telecommunications services. An important example is the introduction of an information collection and processing network linking the switching systems in the nationwide telephone network to central computers. This network provides what is called "Common Control Interoffice Signaling," or CCIS for short, and it will set up telephone connections more quickly and more efficiently than ever before. Improved efficiency will help control costs, but, further, the power of the CCIS concept can be used to provide new connection services.

Progress in the four technologies that I have reviewed briefly will provide new opportunities for applications of telematics in the 1980s. Some of the applications are in the process now and others are being planned.

There are forces other than technological, though, that will shape the ways that telematics services are developed. Political, economical and social factora will dictate how new systems are created and used, but we will need anuther forum to discuss them. ◆

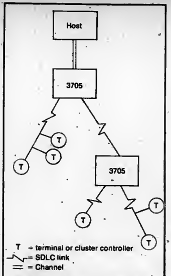
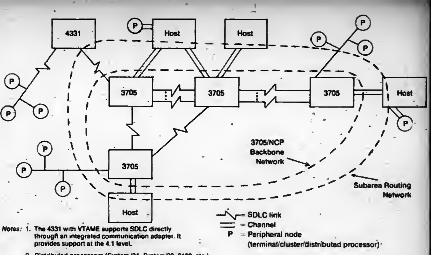


Figure 1. Early SNA Configuration


4331
Host
Host
Host
Host
3705
3705
3705
3705
P
3705/NCP Backbone Network
Subarea Routing Network
= SDLC link
= Channel
P = Peripheral node (terminal/cluster/distributed processor)

Notes: 1. The 4331 with VTAME supports SDLC directly through an integrated communication adapter. It provides support at the 4.1 level.

2. Distributed processors (System/34, System/38, 8100, etc.) present a peripheral node appearance to the subarea routing network but provide a "passthrough" capability to their own separately controlled networks in which they act as subarea nodes

Figure 3. Routing View of an SNA Network

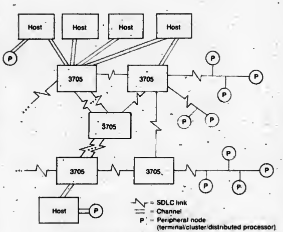


Figure 2. Example of an SNA Configuration Today

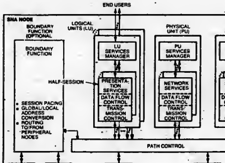


Figure 4. Structure of an SNA Node

By Gary D. Schultz

AN ANATOMY OF SNA

In September 1974, IBM announced Systems Network Architecture (SNA) as its design blueprint for interconnecting IBM products into networks. The promise then was that SNA would evolve in accordance with developing technological capabilities and customer requirements.

In the ensuing 6-1/2 years, SNA has been enhanced in numerous ways. Some highlights include:

• The number of IBM hardware products with software support conforming to the common rules, or *protocols*, of SNA has grown substantially. Besides the 370,

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"SNA configuration flexibility has grown from a host-rooted tree structure to a fully meshed network."

Series 30 and 4300 families of host processors and the 3705 communications controller, more than 30 distinct terminals, cluster controllers and distributed processors (8100, System/34, System/38, Series/1 and so on) now belong to the SNA family of compatible products. These in turn can attach various display heads, printers and other devices.

- Software support on the 370, Series 30 and 4300 families for SNA networks has broadened to include all major IBM host operating systems, several host access methods (Vtam, Vtame and Tcam), remote job entry (JES2/3, Power and RES), data base/data communications support (IMS and CICS), time-sharing (TSO and VSPC) and office support systems (Disoss).
- SNA configuration flexibility has grown from the initial single-host-rooted tree structures (see Figure 1) to fully meshed "backbone" networks of 3705s interconnecting multiple, peer-coupled hosts, along with clusters, terminals and distributed processors (see Figure 2).
- Data presentation services have been defined that provide application programs with *generic* interfaces for multiple-device workstatiuns, video displays and printers. More recently designed application program interfaces in IMS and CICS allow the location of distributed data bases and transaction processing to be transparent to users.
- SNA product support for pre-SNA devices has evolved along with other SNA enhancements. Native protocol support for various pre-SNA devices preserves the original protocol appearance of the device, and the device can be directly attached to an SNA product or can share the SNA backbone network with SNA devices.

SNA has been enhanced in stages, corresponding roughly to major releases uf the 3705 Network Control Program (NCP) and the two major access methods, Vtam and Tcam. These stages, or levels, of SNA have been referred to as SNA 0, 1, 2, 3, 4.1 and 4.2.

This article describes the various features of SNA, emphasizing the more recent capabilities added by levels 4.1 and 4.2.

Physically, an SNA network consists of various kinds of nodes: host processors, communication controllers, terminals, cluster controllers and distributed processors.

Functionally, SNA provides a bilevel (global/local) *path-control* architecture for network routing, flow control and source/destination addressing, with additional SNA-defined user services and network management functions built upon it (see Figure 3).

Host processors and communication controllers provide global path-control services, and so are called *subarea nodes* in SNA. All other nodes are known as *peripheral nodes*. Subarea nodes form the global (high-level) subarea-routing network, while peripheral nodes perform local (lower level) routing functions and use *boundary-function* support (that is, for network-wide/local address conversion) in adjacent subarea nodes to gain access to the full routing network.

The term *subarea node* derives from the partitioning of the global-network address space into *subareas*, each having a unique subarea address. A subarea consists of a single subarea node and the links and peripheral nodes directly attached to it.

Within each node are various functional elements that provide specialized services and are addressable within the subarea-routing network by specific *element* addresses within their given subarea. Some of these elements, called *logical units*, provide an interface for end users (terminal operators or application programs) of the SNA network to communicate with each other. Other elements, called *physical units* and *system-services control points*, provide nodal and multinodal control services, respectively.

Each SNA node is patterned after the layered architectural representation shown in Figure 4, with a path-control element for routing, a data link control (DLC) element for each attached link and a *physical unit* (PU) to activate and control the links and monitor and manage changes to the node resources. A variable number of logical units (LU) may exist. These provide access to other end users and network services for application programs and terminal operators. End users communicate after their underlying LUs have been logically connected by a *session*.

Optionally, a node may contain a *system-services control point* (SSCP), which has multinodal supervisory responsibilities related tu network directory services, configuration management, session establishment, network operator/administrator access to PUs and coordination of network statistics gathering and problem determination. SSCPs are implemented in host processors, with distributed processors providing subset capabilities for separate, smaller networks that they independently manage.

The LUs (PUs, links and so on) defined to a given SSCP constitute its *domain*. Initiations of cross-domain LU-LU sessions involve the joint action of the responsible SSCPs to resolve the names and help establish the session. SSCPs also retain status on LU access and can turn aside or queue session initiation reqoests, based on LU availability.

Domains can *overlap*, thereby allowing serial or parallel control of resources by multiple SSCPs. This allows backup of one control point by another in the case of failure or normal switch-over procedures.

Within each LU, a *half-session*, consisting of presentation services, data flow control and transmission control elements, exists for each session that the LU has active. A session consists of a half-session at each end; together the half-sessions synchronize the interactions between the users of the session. (In addition to LU-LU sessions, SSCP-SSCP, SSCP-PU and SSCP-LU sessions are possible).

Presentation services provide data formatting and other conveniences (such as compression/compaction).

Data flow control provides functions for sequence numbering and logical chaining of user messages, for correlation of requests and responses between the users, for control of send/receive concurrency between them and for serially multiplexing ("bracketing") distinct transactions, such as for data base applications.

Transmission control enforces end-to-end, session-level pacing (described later) and provides enciphering/deciphering of session traffic.

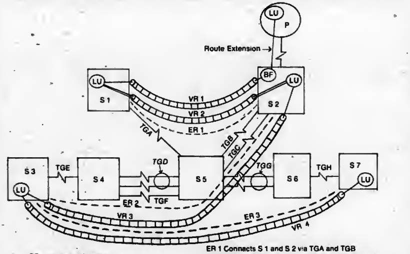
Routing Requirements

In the early releases of SNA, routing requirements were relatively simple. The single-host tree structures needed little more than straightforward, receive-and-forward routing from source to destination over a single fixed path between them.

In anticipation of larger configurations, and greater dependence on them to handle vital business applications, SNA was enhanced in 4.2 to improve the availability and performance of networks. One improvement introduced *multiple-active routes* between end subarea nodes. This allows increased availability and load leveling, as well as alternate-route selection following a failure on one route or to separate traffic for different applications (e.g., batch and interactive).

SNA 4.2 routing introduced three nested, path components within the subarea routing network: *transmission groups*, *explicit routes* and *virtual routes* (see Figures 5 and 6). Transmission groups connect adjacent subarea nodes and consist of either a channel connecting a host to a 3705 or one or more SDLC links connecting 3705s.

Virtual routes are built on top of explicit routes and introduce protocols for transmission priorities and global flow control of traffic between source and destination subarea nodes. Virtual routes can be multiplexed on the same explicit route; in turn, multiple sessions can be multiplexed on a single virtual route (see Figore 5). Virtual routes allow three transmission priorities to be imposed on explicit routes;



BF = boundary function
LU = logical unit
P = peripheral node
S = subarea node
⌇ = channel or SDLC link

ER 1 Connects S 1 and S 2 via TGA and TGB
ER 2 Connects S 3 and S 2 via TGE, TGF, and TGC
ER 3 Connects S 3 and S 7 via TGE, TGD, TGG, and TGH.
VR 1 and VR 2 are built on ER 1 (using different priorities).
VR 3 is built on ER 2.
VR 4 is built on ER 3.

Figure 5. TGs, ERs and VRs in a Network

"Typically, networks are designed so that maximum throughput is less than the offered load at peak operating conditions."

hence, up to 24 distinct virtual route appearances can be constructed between any two end subarea nodes.

Virtual routes stop at subarea nodes. The portion of a session path connecting a half-session in a peripheral node to the boundary function in an adjacent subarea node (and thus to a virtual route) is called a *route extension*.

A virtual route is activated only when the first session is assigned to it. Activation messages are exchanged to synchronize the two end nodes and to set initial flow-control parameters for the virtual route. It is deactivated when the number of sessions assigned to it drops to zero.

A session is assigned to a virtual route according to a network-level *class of service*, as requested in the end user's (log-on) request for the session.

A class-of-service *name* (such as "secure," "batch" and so on) indirectly determines the underlying virtual route, so that end users remain independent of the network configuration. The name is used (by an SSCP) to select a list of suitable virtual routes; the first virtual route in the list that is (or can be made) available is chosen for the session.

A virtual route has a transmission priority that determines where its traffic is inserted in the underlying transmission-group queues. These queues have three levels, corresponding to three priorities, for regular network traffic. (A unique, highest priority is used for flow-control responses on virtual routes.) Traffic is placed on these queues and is transmitted according to priority, thereby expediting higher priority traffic along the explicit route. An aging algorithm at each node periodically reorders its queues to allow low priority traffic not to linger indefinitely in the node.

Local and Global Flow Control

Any owner of a network wants to get the best performance possible out of it, while using the configured resources to their utmost to minimize wasted capacity. Typically, network configurations are designed so that maximum throughput is less than the offered load at peak operating conditions. Thus, resources need to be efficiently and fairly shared among users, and network throughput should not be degraded with increasing load.

Techniques for controlling congestion, and adaptively allocating resources according to need and availability, are called *flow control*.

SNA has flow control at different levels, as indicated in Figures 6 and 7.

Session Pacing. Two communicating end users frequently have an inherent saturation rate, whereby incoming traffic exceeds the processing capability and buffer storage available to hold it.

For this reason, each sender has a maximum number of message units (fixed at session setup time) that can be sent prior to receiving a go-ahead *pacing* response from the receiver to continue sending. Each group of message units is called a *window*, and the window size can be different in the two directions between the end users.

A receiver can return a pacing response after receiving the first message of a window, or it may delay returning it if it is falling behind. On receiving a pacing response, a sender has a "credit" to send the next window, in addition to any portion of the current window remaining to be sent. This number, called the *pacing count* (message units credited to be sent), can range from 0 to 2w-1, where w is the window size.

Session pacing operates at two levels. It moderates traffic from end user to end user; in addition, the boundary function can withhold pacing responses intended for a peripheral node if a virtual route serving that node is congested; this limits a session's traffic over the route extension into the network in order to ease the load enqueued at the boundary node on an underlying virtual route.

Virtual-Route Pacing. Virtual-route pacing operates in a fashion similar to session pacing, except that it controls the flow from end subarea to end subarea and adaptively changes window sizes according to network conditions.

At virtual-route activation time, the minimum and maximum window sizes are set at each end subarea node as a function of the underlying explicit-route hop count, h (determined at explicit-route activation time). This relationship of optimal window size to some function of hop count is widely agreed upon in the industry. (Other network architectures described in the literature that use window techniques adapt also according to some function of h.)

Window Size

For SNA, analysis and simulation studies have led to varying window size between h and 3h, where h differs from route to route. The multiplier, 3, is used based on the argument that 2h is enough to allow for the number of roundtrip hops (the window should be large enough to keep the send direction occupied until the pacing response can be returned), while 3h should accummodate a moderate use of parallel links per hop within the route.

The variation of window size between the minimum and maximum during use depends on resource availability at the end points of a virtual route and at the queues along the way.

If a sender receives a pacing response before it has completed sending the current window (pacing count greater than 0), it will either decrement the next window size (because of a request in the pacing response to do so) or leave it the same. (The virtual route is handling traffic faster than it is offered.)

The request to decrement can result in decrementing the next window size by one (but not below the minimum) or in resetting it immediately to the minimum. In the latter case, the current window is truncated and any unsent message units become members of the next (smaller) window. (Two different indicators, based on congestion conditions, are used in the pacing response, with the more severe indicator having precedence.)

If a pacing response is received when the pacing count equals 0, a request to decrement is also honored. However, if no such request is indicated, the window size is increased by one (but not above the maximum) to take advantage of the apparently available capacity. (The sender has been idle — having used up its credits before receiving a go-ahead — and no congestion is indicated.)

Requests for a sender to decrement its sending window size may be issued not only by the end node on the virtual route, but by intermediate nodes along the route.

An intermediate node may be experiencing congestion on an outbound hop used by a specific virtual route. Depending on the severity of the congestion, *back pressure* (feedback) to relieve the hop congestion can be signaled in two ways. Upon detecting that a transmission-group queue is moderately congested, the intermediate node can "tag" (set an indicator in the header of) any message unit it places in the queue, to command the virtual-route end-point target of the tagged message unit to help relieve the moderate congestion in its receive direction. To comply, the receiver returns a command in the virtual-route pacing response to inform its virtual-route partner to decrease its send window-size by one.

When an intermediate node has a severely congested transmission-group queue, it tags all message units going back to those virtual-route end points sending in the congested direction, to command them to "slam" their current windows and reset their send window-sizes to the minimum values. The back-pressure to relieve hop congestion is selectively applied and does not penalize noncontributors to congestion.

SDLC Control. Synchronous Data Link Control (SDLC), like ISO's High-Level Data Link Control (HDLC) (of which SDLC is a conforming subset), supports flow control between adjacent nodes. This uses the link-level Receive-Not-Ready (RNR) signal, informing an adjacent node not to send additional traffic until a Receive-Ready (RR) signal is sent by the congested node. In SNA, this is a last-resort signal when other flow-control techniques are insufficient.

The 3705/NCP uses RNR control to stop traffic from all attached peripheral nodes when it is in a special state called *slowdown*. It enters this state automatically when it crosses a buffer-depletion threshold.

The NCP notifies the network operator, via the SSCP, of its entry into slowdown. (Later, it reports its return to normal operation.) On-line machine traces can contribute heavily to congestion, so the NCP will deactivate any ongoing traces upon entering slowdown. If traces are not the cause, persistent occurrences can indicate a fundamental configuration imbalance.

Operational Control

Owners of networks of even moderate size quickly learn the value of organized management of network operation and problem determination. Within SNA networks, integrated techniques allow *centralized* or *distributed* operator management of the network configuration. These techniques were introduced first in SNA 3 and extended considerably in SNA 4.1 and 4.2.

The IBM program product, Network Communications Control Facility

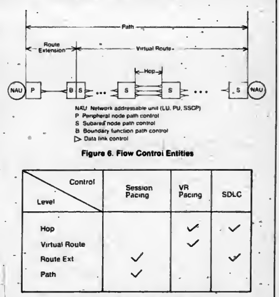

Path
Route Extension
Virtual Route
Hop
NAU
P
B
S
S
S
S
NAU
NAU Network addressable unit (LU, PU, SSCP)
P Peripheral node path control
S Subarea node path control
B Boundary function path control
▷ Data link control

Figure 6. Flow Control Entities

Control / Level	Session Pacing	VR Pacing	SDLC
Hop		✓	✓
Virtual Route		✓	
Route Ext	✓		✓
Path	✓		

Figure 7. Flow Control at Different Levels

"Exact matching of OSI and SNA layers is not as relevant as functional equivalence of the layers taken as a whole."

(NCCF), allows operator control messages to be issued between a central operator at a 3270 CRT terminal (or multiple, distributed operators) and one or more SSCPs in the SNA network.

Essentially, NCCF allows an operator to exercise control by gaining access to the SSCP-PU sessions, which can be used, for example, to update configuration information as required to add, delete or move a peripheral node somewhere in the network.

Many network owners like to centralize operator administration of their networks, particularly for "help-desk" problem monitoring.

An alternative way to achieve central control is to define all the nonhost resources in the network only in the domain of a single SSCP. All problem-determination responsibility for these resources then passes through the single host. SSCPs in other hosts concern themselves only with application usage of the nonhost resources. This partitioning of control domains is called the *communication management configuration*. In this case, a central operator, using a single NCCF, could access the one SSCP to reach all nonhost PUs. (Variations to increase the number of responsible SSCPs to improve performance or availability may be desirable.)

NCCF also provides support for user- or IBM-coded application command processors to be run at the host. These can be used to simplify human control through programmed operator control or to tailor specific control functions of the user's choice. NCCF allows a single (Vsam) file to be shared among multiple network-management applications and provides various 3270 screen-management functions for convenient display of information.

The Network Problem Determination Application (NPDA) is an IBM program product that runs as a command processor on NCCF. It collects, summarizes, analyzes and displays maintenance data and other statistics.

NPDA can alert a network operator to conditions that exceed specified error threshold rates in order to provide advance warning before an actual failure occurs. On receiving notice of an actual failure, the operator can use NPDA to display error records. NPDA provides a "probable cause" of an error. The operator can use the NPDA and NCCF services to run faster tests to isolate the error condition.

A number of failure-reporting mechanisms exist in SNA. Session damage is reported to both end points of an affected session. This allows an orderly termination of that session by both ends and resumption of a new one, possibly using a different route (with the same class of service) to bypass an outage.

Often, terminal operators must reinitiate the session, but aids for programmed reinitiation exist in specific products. For example, with Tcam, CICS and IMS, session reinitiation can be done without human action. Tcam provides a session-reinitiation macro, while IMS and CICS provide programmable operator support for reinitiating sessions. IMS restarts an incomplete transaction automatically, while CICS requires restart processing to be programmed by the user.

Failures of routing components such as links and virtual routes are also duly reported so that appropriate recovery action can be invoked to restore the configuration. Various backup techniques exist: reverting to switched links when leased links fail, activating backup SSCP takeover of all or part of a domain that is failing and so on. Takeover and subsequent restart by an SSCP can be nondisruptive to ongoing LU-LU sessions. Additional means for testing, tracing, dumping and re-IPLing various logical and physical components of the network exist to assist in return to normal operation.

SNA and Standard Protocols

Various international standards organizations, such as CCITT and ISO, are developing standard protocols for different levels of network operation.

CCITT has recently developed an "X" series of recommendations defining the interfaces between data terminal equipment and public data networks offered by common carriers.

ISO is developing a seven-layer reference model for Open Systems Interconnection (OSI), whereby systems from different manufacturers can be interconnected via standard protocols. This ambitious undertaking is intended ultimately to permit comprehensive interconnection from the physical level up through the highest level of application-to-application interaction and network management. (CCITT Study Group VII has adopted this model as the basis for development of a layered model of its own).

Today, standard protocols are defined for the three lowest layers, while work is in progress to define standards for the higher layers. (For more details on OSI, see the paper by the chairman of the architecture working group on OSI, H. Zimmerman: "OSI Reference Model — The ISO Model of Architecture for Open Systems Interconnection," *IEEE Transactions on Communications*, April 1980.)

Work on OSI in ISO (by the working group, SC16) began, according to Zimmerman, in early 1978. Definition and refinement of the reference model of OSI, which is the framework for developing standard protocols, occurred during 1979 and 1980.

The reference model essentially describes the layers in general functional terms to enable ISO to relate previously defined detailed standards to the framework layers and to develop new standards. ISO is sponsoring working groups to develop detailed standard protocols for layers where no standards yet exist and to augment layers where existing standards do not provide all the functions the reference model calls for. (The reference model itself has been in a state of flux, with functions being added, refined or moved as work has proceeded.)

SNA, several years prior to OSI, defined functionally equivalent layers at all levels, in order to provide the necessary support for existing networks. This section briefly sketches the relationship between OSI and SNA. Until detailed protocols are actually defined for OSI, comparisons such as this are tentative.

It should be noted that, as Zimmerman pointed out, adherence to OSI is measured by external behavior — interactions between communicating systems. The internal function placement and organization of a system are outside the scope of OSI, since only the external behavior is visible to an interconnected system. Thus, exact matching of OSI and SNA layers is not as relevant as functional equivalence of the layers taken as a whole, which allows interconnected systems to have compatible external behavior.

OSI Level 1, *the physical layer*, corresponds to the same layer defined in SNA. This provides the interface between data terminal equipment, such as a communication controller or terminal, and data circuit terminating equipment, such as a modem.

SNA products support many physical-layer standards, such as the CCITT recommendations, V.24 (and its EIA equivalents) and V.25, for telephone networks, and X.21, in selected cases, where national carriers have provided this new service for data networks. V. Ahuja and A. Barclay (In "Compatibility of SNA and the CCITT X.21 Interface," *Conference Record* Vol 1, NTC, November 1979) describe in detail how X.21 fits into SNA. (X.21 is also Level 1 of CCITT Recommendation X.25.)

OSI Level 2, the *data link layer*, corresponds to SNA's DLC layer. An example of a standard link control is ISO's HDLC, of which SNA's SDLC is a conforming subset. (X.25's Level 2, LAP B, is also a subset of HDLC.)

Levels 3, 4

OSI levels 3 and 4, *the network and transport layers*, correspond functionally to SNA's path-control layer; the transport layer also contains some functions (such as session-level pacing) that are placed in the transmission-control layer of SNA.

ISO includes CCITT's X.25 Level 3 as a standard packet-switching interface for public data networks, with no standard yet defined for interconnection of private networks. X.25 Level 3 provides a network interface that provides *virtual-circuit* appearances to the upper transport layer.

A theoretical limit of 4,095 virtual circuits (switched or permanent) can be provided between a single end-user node and an access node of the public data network. (A much lower number, such as 256, is frequently implemented in practice.) Each virtual circuit can, in principle, be used to route to a different destination end-user node. Flow-control window sizes are statically set at circuit setup time for switched virtual circuits or at subscription time for permanent virtual circuits. (For additional details on X.25, see the paper by A. Rybczynski, "X.25 Interface and End-to-End Virtual Circuit Service Characteristics," *IEEE Transactions on Communications*, April 1980).

The transport layer is intended to provide additional services related to performance levels (error rates, reliability, cost-effectiveness and throughput) required for higher layers, as well as to provide full end-to-end routing connections between using session layers. (Level 3 connects the end nodes, rather than the end session partners.) Currently, ISO has no fully defined standards for Level 4.

SNA's path control provides functions satisfying both the end-node-to-end-node routing of OSI Level 3 and the connection of end-session entities provided by OSI Level 4. Some of these functions are equivalent in nature to X.25 Level 3, but not identical.

F. Corr and D. Neal (in "SNA and Emerging International Standards," *IBM Systems Journal*, Vol. 18, No. 2, 1979) have discussed various possible designs for including X.25 support within SNA networks, as well as actual SNA product adaptations (for the 3705 and the Series/1) that do so. The first of these (for the 3705) was released in 1977 and now is supported in five countries (Canada and in Europe), as well as in Euronet. IBM has stated its intent to extend SNA support for X.25 in the future.

Levels 5, 6, 7

OSI Level 5, *the session layer*, corresponds to SNA's transmission-control and data-flow-control layers (except, as mentioned above, for some session-related services that ISO places in Level 4). Currently, ISO is actively developing standards for this layer, and various national standards bodies have proposed functions similar to SNA's session-level capabilities, such as bracket control.

Level 6, *the presentation layer*, corresponds to SNA's existing presentation services layer. Again, no standard has yet been adopted by ISO, although standards are being developed.

OSI Level 7, *the application layer*, contains services not yet standardized by ISO.

According to Zimmerman (In the paper cited above), these services relate to application-, system- and layer-management functions — roughly equivalent to the functions currently provided by SNA's LU, SSCP and PU services managers.

Future Results

He added that little work by ISO has been done here and it is too early to predict future results. This is, however, a significant area and one that will have to be addressed, since the functions apply to network monitoring, diagnostics, reconfiguration and other vital administrative services of working systems; their absence will affect the exchange of these services across open systems interconnections.

While the preceding discussion indicates that much work lies ahead to define comprehensive standards, nonetheless, standardization of network protocols remains a long-sought ideal to permit interconnection of systems of various manufacturers.

IBM actively participates in the development of standards. Implementation of standards, of course, is done based on business judgments. Historically, IBM has had a strong record in its implementation of adopted standards.

◆

A SURVEY OF DISTRIBUTED NETWORK ARCHITECTURES

By Gerard L. Power

This article is a survey of distributed network architectures available commercially from several systems vendors.

The article begins by presenting an overview of network architectures and the motivation behind their development.

It then covers the architectures available from Digital Equipment Corp., IBM, Burroughs Corp. and Sperry Univac.

The Open Systems Interconnection Reference Model developed by The International Standards Organization is then introduced and used to illustrate the logical consistency between the previously defined systems.

A brief comparison of the various systems is then presented, covering some of the key issues not mentioned in the previous sections.

Finally, a number of network architectures available from other vendors are briefly described to show the wide variety of systems presently available.

In most cases, the information presented here is severely limited by the varying amounts of printed material made available to the public and the rate at which it becomes obsolete.

Therefore, this work is not meant to be a complete comparison of the presented network architectures, but is an overall broad-based viewpoint that the reader may use to begin such a comparison or to aid in the development process of a computer network.

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This article is the result of work recently completed by the author while a computer science research assistant at Pennsylvania State University.

Although data communications facilities and crude computer networks have been in existence for some time, networks have come into widespread use only recently. This can be largely attributed to two specific facts.

First, as computer prices continue to decline, computer networks requiring a large amount of hardware are becoming more affordable. Second, only recently has any effort been put forth toward developing sophisticated data communications standards.

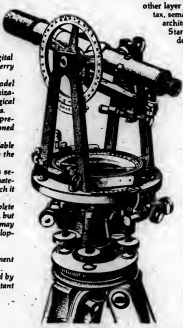
Early data communications attempts were limited in capability, application-dependent, extremely complex in structure (usually being implemented through some form of terminal emulation) and extremely expensive to maintain. In a complex system, network architectures (a formalized definition of the interaction required to provide shared data communications functions) are necessary in order to keep the hardware and software used to perform the various distributed processing functions from becoming uncontrollable monsters.

A computer network is a physical system consisting of a collection of computers connected by some communications facility. Each computer forms a separate node within the network. Distributed processing is accomplished by subdividing a task into a series of subtasks that can be divided among the nodes in the network. The communications services provided to allow these subtasks to pass information between themselves are an extension of the operating system.

The network architecture defines how these communications services are logically structured and what functions they provide.

Network architectures are usually structured as a series of hierarchical layers, with each layer building on the layers below it. These layers make it easier to design in detail, describe and implement the complete system. In addition, they make it much simpler to isolate future modifications to a small subset of local modules, making maintenance less of a chore.

The formal definition of how one of these layers communicates with another layer is called the protocol. The description of the protocol syntax, semantics and orderings makes up the majority of the network architecture specification's content.



Starting from those specifications, a network design may be described, and from this design an implementation may be realized, but the architecture does not directly force a specific design or implementation on the developers. Most vendors offering a general-purpose distributed processing facility have such a defined architecture. These architectures allow the vendors to be in a position to offer the users a wide range of networking options from a consistent communications philosophy.

This article will examine several such architectures, chosen because of the wide variety of machines on which they can be used. It is meant to provide a broadly based background from which the reader can continue his inquiry into the specific systems of interest to him, to provide a background for acquiring such a system and to illustrate the many details involved in developing such a general-purpose distributed network architecture.

Why Distributed Processing?

A properly designed distributed processing system has the potential to provide several advantages over an entirely centralized system. Since remotely originating data queries are far more expensive than local queries, by placing the data at its point of need or point of highest utilization, the distributed system can potentially reduce the overall communications costs and improve response time, especially in a geographically dispersed organization.

A distributed system may be built on a series of smaller computers rather than on a single massive machine, "Distributed processing networks are more reliable than a single centralized machine since they are not as susceptible to total system failure."

thus reducing the total hardware and software costs through economies of specialization (as hardware costs continue to decline this will become a benefit of increasingly greater value).

Distributed processing networks are more reliable than a single centralized machine, since they are not as susceptible to total system failure. Should one computer site fail because of hardware or communications faults, the other computers can remain up and functioning.

A distributed system can grow as the data processing requirements grow. When the processing done on a single centralized machine begins to push the capacity of that machine, that unit must be upgraded significantly (often requiring a new machine); on the other hand, in a distributed system, one can easily add a new processing node where and when it is needed.

The network allows the computing facility to model itself after the organizational structure it is meant to service. Each site is allowed to tailor the facilities (and supporting staff) to fit its specific requirements. The data used at each site for technical and management decision making is globally available to all sites within the system.

Finally, it should be noted that although these advantages are realistically achievable, a distributed network is much more complex than a centralized system, and so errors made in doing network design can be difficult to correct and small errors can easily magnify themselves to have disastrous results. (The many application-related issues that can arise in distributed network processing, such as the problems involved in the implementation of a distributed data base, are not covered in this article; many are, however, covered in several papers previously written by the author.)

Distributed Difficulties

Users encounter a number of difficulties when trying to develop a flexible general-purpose distributed processing system. One of the major problems is in the nature of the field of distributed processing. It is a complex mix of a number of high-technology fields encompassing the computer and communications industries.

The environment in which the distributed processing system is being developed is dynamic and turbulent. Until recently, little effort had been directed toward the development of an industrywide standard, making multivendor communications systems extremely difficult to implement. Several organizations including the American National Standards Institute (Ansi), the Consultative Committee on International Telephone and Telegraph (CCITT) and the International Standards Organization (ISO), have attempted to establish some industry standards. However, because of the many functional implementation levels of these standards which can be used, one must question whether these present efforts can really help solve the standardization problem.

An example of the incompatibility of the different levels of standardization are the three existing X.25-compatible public data networks (PDN): Telenet in the U.S., Transpac in France and Datapac in Canada. X.25 is a CCITT recommendation that was originally defined in 1976.

Although all three PDNs define themselves as fitting within X.25's guidelines, equipment designed to run with one will not directly work with a different PDN. Since the X.25 systems mentioned above were imple-

"The user's application should determine the distributed network's characteristics; the network should not limit the application's usage."

mented, a revised version of X.25 has been approved (February 1979); it has tried to address itself to clearing up the ambiguous areas of the original version which led to these "standard" incompatibilities.

Another significant problem in vendor-developed distributed processing systems is the salesmanship conflict. A major reason for the implementation of a distributed processing system is that each site can install and use a computer that is particularly well suited to the needs of that site and can also connect with and make use of the specialization of other network nodes. Thus, developing networks tend to be made up of many types of equipment from many different vendors. Unfortunately, the vendor's prime interest is to sell as much of its particular equipment as it can. This fact, combined with the pressure placed upon the salesman to fulfill his quotas, goes directly against allowing for the development of multivendor processing networks.

When a distributed network is being implemented, the user's application should determine the network's characteristics; the network should not be allowed to limit the application's usage. An ideal general-purpose distributed processing system should have the following characteristics:

1) It should be adaptable for multivendor network use.

2) It should not make any restrictions on the network topology and should allow changes to be made easily in the topology.

3) It should not require that the end user know anything about the network topology or how the network functions are implemented.

4) It should be program- and device-location independent — that is, any remotely connected device should be accessible as though it were logically locally connected.

5) It should allow for interprocess (task-to-task) communications.

6) It should detect all errors and recover from them whenever possible.

7) It should not require the user to perform any complicated control procedures.

8) It should be developed in a systematic layered manner with strict interfaces and protocols being defined for the interaction of any given layer with its adjacent corresponding layer.

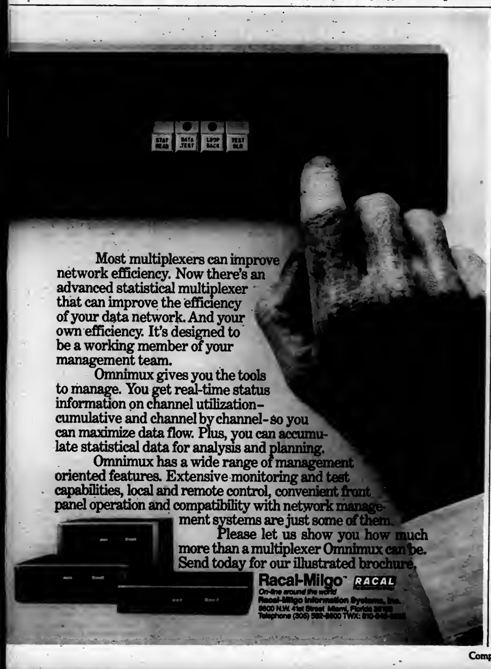
These criteria are necessary in order to guarantee the development of a reliable network of maximal flexibility while minimizing the complexity and limitations of the network from the user's point of view.

Digital Network Architecture

Digital Network Architecture (DNA) is Digital Equipment Corp.'s distributed network architecture. It is implemented through the Decnet program product, which was originally released in 1975. Decnet Phase II was announced in March 1978 and Phase III, the present version, was announced in February 1980. As Phase III is so new, it is not yet available over the full range of DEC systems.

The appropriate release of Decnet to be used at a given node is determined primarily by which operating system is to be used in conjunction with the networking software package (networks of mixed releases are supported with a limited range of capabilities).

Decnet contains three distinct software layers: the dialog layer; the logical link layer; and the physical link layer. Each layer is made up of a set of distinct modules that allow for the building of Decnet nodes containing a functional subset of the total possible Decnet capabilities. This allows each site to tailor its capabilities in order to minimize



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> **"In DNA, the dialog layer is the end-user interface. Access is made through a set of Decnet subroutines or through the operator interface."**

the total requirements of each particular node.

The Dialog Layer is the end-user interface to the system. It contains the network file access and file access listener utilities which, through Record Management Services (DEC's general-purpose file handler), manage operator-initiated file movement requests and remotely controlled file read and write requests, respectively. Remote device access requests will produce data access protocol (DAP) messages in this layer, while network control messages produce network information and control exchange protocol (Nice) messages. Access to this layer is made through a set of Decnet system subroutines or through the operator interface. The dialog and logical link layers are linked into the application program, while the physical link layer resides within the operating system's device handlers.

The Logical Link Layer will either append information to the DAP messages produced in the dialog layer or create messages of its own. In this layer, the messages are packeted and the logical routing information is appended to each packet. This layer is also responsible for initiating and terminating sessions and for detecting and correcting logical link errors that may occur during the communication session.

Messages from several users are multiplexed into a single stream and are usually handled in a first-in, first-out manner; however, priority messages can be sent directly to the head of the transmission queue. The messages created by this layer which are to be passed to a remote logical link layer conform to the network services protocol (NSP) rules.

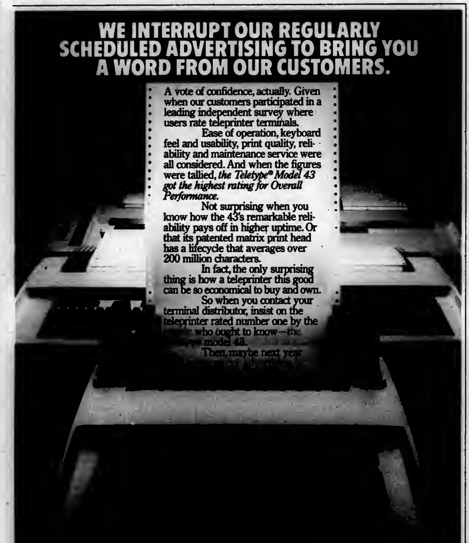
It is this layer (in the transmitting node) which controls flow control by requesting permission to transmit a specific number of messages to the receiving node. This number, which may be altered by the receiver, indicates the amount of buffer space available for messages received. After a message is processed and its buffer space freed, further message transmission requests may be made. In addition, this layer checks the status of an inactive line periodically in order to assure that the transmission line is still functioning properly.

The Physical Link Layer handles the actual transmission lines. By appending control information to each NSP unit, this layer creates messages of the digital data communications message protocol (DDCMP) form. The packets are sequenced here for transmission and then sent over the line. Upon receipt of a packet from the communications line, this layer will examine the packet for transmission errors and, should any be found, the receiving node requests retransmission of that packet sequence, beginning with the packet found to be in error. The node that originally transmitted the packet will maintain that packet until positive acknowledgment of reception is received from the next node in line.

DNA Message Flow

DAP messages, when created in the dialog layer, consists of a flag, command-type indicators, an optional I/O channel indicator, a length specifier and some operational information. When the logical link layer breaks its received messages into packets, it creates a series of NSP-formatted packets.

There are two types of NSP packets: control and message. Control-type NSP packets are used to pass messages to the logical link layer in adjacent nodes; message-type NSP packets assist in passing messages from a source dialog layer to a destination dialog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> "Much of Phase III's flexibility comes from the network management layer, which didn't really exist in earlier releases."

layer. Both types of NSP packets also begin with a flag and a physical destination address.

Message packets also contain a logical destination address, which is assigned at the time of session initiation, the address of the message's source, a sequence packet number to rebuild the message properly from the packets and the packet message itself.

Control packets contain an additional length specifier, a control message-type indicator and a packet message. Control packets are used to connect or disconnect a session's nodes, to inform remote nodes of logical errors and to obtain status information.

DDCMP units are built in the physical link layer. They also have two forms: data and control units.

Data units are used to pass packets received from the upper layers to corresponding layers in adjacent nodes. They consist of a flag, a packet length specifier, a poll flag used to pass line control between connecting stations, a received sequence indicator, a physical destination address, the packet itself and two block checking segments (one for the header and one for the message packet proper.

Control units are used to pass information between physical link layer entities and are essentially a specialized form of the data unit without the packet field and its block checking segment.

Positive acknowledgment of the correct reception of a series of no more than 255 packets must be received by the transmitting station or an error condition, such as a line failure, is assumed to exist. If the reception of a transmission error is detected, retransmission beginning with the packet containing the error is immediately requested. If a full-duplex line is being used and messages are being transmitted while being received, then a message being sent can carry with it a message informing the remote node of the successful reception of a packet series.

Phase II

The only form of communications that is supported by Decnet Phase II is within point-to-point adjacent sessions. That is, two nodes can communicate over either synchronous or asynchronous, serial or parallel lines in a full- or half-duplex manner only if there is a direct connection between those two nodes.

One node may have up to 64 nodes connected adjacent to it and may support up to 255 sessions between those nodes con-currently. Usually, however, no more than 10 nodes per network are directly connected as the communications processing would utilize most DEC machines' full processing power at peak load times. Cooperating processes, which may reside in either two distinct nodes or the same node, are allowed to pass messages between themselves in doing task-to-task communications.

Decnet also supports operator-requested file transfers between nodes and remote peripheral-access requests where the peripherals connected to a remote node may be accessed as though they were connected locally.

When remotely accessing a file residing on a direct-access device, such as a disk, random or sequential access of fixed- or variable-length file records can be supported. Remote command submission, down-line program loading and down-line system loading capabilities allow users or programs in one node to submit system commands to a remote node; to request program execution in another node even though the executable code may be physically stored in another node; and to request the bringing up of a remotely located node (bootstrspping), respectively.

Ramp, a diagnostic program, is also included in the Decnet nodes to aid in program determination. Essentially, this program runs fixed messages through a series of communications loops to isolate fault locations.

Phase III

In Decnet Phase III, the present release, the logical layers have been further broken down and added to, which will make it easier to implement multivendor networks through Decnet.

The dialog layer is subdivided into a user layer, which represents the network user's application; a network management layer, which is responsible for controlling and monitoring the network's configuration; and a network application layer, which provides the remote file and terminal access capabilities.

Much of Phase III's increased functionality is provided by the network management layer, which did not really even exist in the earlier Decnet releases. Unlike the other layers, it has the ability to directly access any of the other system layers.

The logical link layer became a network services layer, which builds NSP messages; a session control layer,

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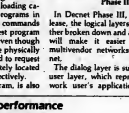

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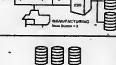
Local network — shared database

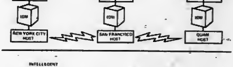
You have a local network: workstations that share a common database. Replacing an expensive host, the IDM serves as the database node on your network. Users can retrieve the information they need for CAD/CAM, MRP, general office support or other integrated multi-department systems.



Distributed network — multiple databases

You have a network with geographically distributed databases. Users throughout the network need fast access to all databases and local updating for MIS, decision support, knowledge-based applications, etc.

The IDM organizes and manages the databases for faster response to queries. Users throughout the network can ask for information on an ad hoc basis without knowing the data formats at each location. The IDM allows you to have your own custom view of each database. You can update your local database. You can change computers or application programs without affecting database management.



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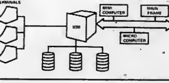

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> **"The addition of the transport layer in Phase III made Decnet a networking system rather than simply a communications package."**

which controls the production and reception of information packets; and a transport layer, which routes the individual packets through the network. The addition of the transport layer in Phase III removed the adjacency constraint and made Decnet a networking system rather than simply a communications package.

The physical link layer is defined as containing the data link elements which ensure error-free transmission of the packets; physical link elements, which are the communications line drivers; and the physical communications facilities themselves.

Phase III made significant enhancements to Decnet Phase II. Polled multipoint communications are supported in Phase III, allowing up to seven nodes to reside on the same communications line. One node, the controller, will be responsible for managing that line by polling each of the other tributary nodes for messages to be transmitted to the host. These tributary nodes may represent a single site, or they may be the control unit of another multipoint line.

Dynamic adaptive message routing has also been implemented and with it the ability of nodes to communicate

GLOSSARY OF DATA COMMUNICATIONS TERMS

ACF: See Advanced Communication Function.

ACS: See Advanced Communications Service.

Adjacent: Two nodes are said to be adjacent if there is a direct physical communications link between them.

Advanced Communication Function: A set of IBM program products built on SNA concepts to allow resource sharing and to distribute network control functions through a distributed resource network.

Advanced Communications Service: An extremely large public data network being developed by AT&T. It is presently scheduled to be operational by 1982.

American National Standards Institute: A standards organization that has defined the Advanced Data Communications Control Procedures (ADCCP) protocol as an industrywide protocol standard. It is very similar in nature to ISO's HDLC.

Ansi: See American National Standards Institute.

Application environment: Represents the end user to a DCA system.

Architecture: Defines a set of system components, the functions these components perform and how they interrelate.

BDLC: See Burroughs Data Link Control.

Bisync: An IBM binary synchronous communications protocol, often referred to as BSC.

BNA: See Burroughs Network Architecture.

Broadcast transmissions: A message transmission that is directed to a large user community rather than to a single user.

Burroughs Data Link Control: The communications protocol designed specifically for operation with Burroughs hardware. It is an HDLC-type protocol.

Burroughs Network Architecture: The communications structure defined by Burroughs Corp.

CCITT: An international standards organization comprised of many telephone/-common carriers and national governments.

Communications controller: A programmable communications line processor which contains the NCP in an SNA network. It manages line control, buffering of data and message routing for the communications lines it controls. Examples include the IBM 3704 and 3705.

Communications system: The layer in DCA that handles all intersystem communications.

Computer network: A collection of computers connected by some communications facility.

Connection point manager: Builds basic information units to be passed to path control and the data flow control layer in an SNA network.

DAP: See Data Access Protocol.

Datagram: A session consisting of a single message without responses or message reception acknowledgment. To transmit a datagram in networks not providing special datagram services, it would be necessary to initiate a session, transmit the message and then terminate the session. Datagram services perform these entire services as a single action.

Data Access Protocol: A specialized protocol allowing for resource sharing between different network nodes in a DNA network.

Data flow control: An SNA layer that can create (or respond to) messages to be sent to other data flow control layers. These messages manage the session dialog and state variables.

Data link control: An SNA layer that manages physical data lines.

Data link layer: A sublayer of the logical link layer in Decnet Phase III that routes packets through the network.

Data pacing: Used to prevent one node or user from flooding another node or user with more information than it can handle.

DCA: See Distributed Communications Architecture.

DCP: See Distributed communications processor.

DDCMP: See Digital Data Communications Message Protocol.

Decnet: The Digital Equipment Corp. program product built on DNA concepts in order to implement distributed processing functions on DEC machines.

Dialog layer: The user interface to a DNA network.

Digital Data Communications Message Protocol: A DEC message transfer protocol used to transmit messages over communications lines.

Digital Network Architecture: A communications structure defined by DEC.

Distributed Communications Architecture: A communications structure defined by Sperry Univac.

Distributed communications processor: A front-end communications processor used by Univac machines.

Distributed processing: The process of dividing a task into a series of subtasks which are processed by equipment that communicates with other equipment to complete the required function.

Domain: A collection of SNA resources under the control of a single system services control point.

DNA: See Digital Network Architecture.

Ethernet: A low-level, local-area communications network concept (proposed as an IEEE standard) being developed by DEC, Intel and Xerox. Its specifications cover only the functionality of the data link and the physical link layer of the ISO model.

End user: The source and/or destination of all information sent through the communications system.

File access listener: The addressable unit in a Decnet session that performs remotely requested accesses to a locally stored file.

Function management layer: Does the presentation mapping between the end user and the rest of the SNA network.

HDLC: See High-Level Data Link Control protocol.

High-Level Data Link Control protocol: The protocol defined by ISO communications protocol standards that passes information packets over a communications line. It was accepted in 1976 from the ISO subcommittee ISO/TC97.

Host services: Provides logical access to a BNA network.

Interface: In a layered system, the interaction between adjacent layers.

International Standards Organization: A standards organization that has created and is presently developing interconnection standards following the OSI recommendations.

ISO: See International Standards Organization.

JCL: See job control language.

Job control language: A series of instructions by which a user defines the resource requirements of a particular job. This may include the specific network needs of that application.

Logical link layer: The intermediate layer that packets and routes messages through a DNA network.

LAP: See Link Access Protocol.

LAP-B: See Link Access Protocol — Balanced.

Link Access Protocol: The unbalanced version of HDLC which requires that the communications line have a single control point to initiate link control and all data transfer actions.

Link Access Protocol — Balanced: A version of HDLC that specifies that the communications line has no single controller so that either connected station may control the state of the link.

Logical unit: The addressable unit that represents the end user in an SNA network.

Logical unit services: The elements in the function management layer that react to commands from the end users and the SSCP within an SNA network.

Management environment: Manages the and user's access to the communications system in a DCA network.

Master control program: A part of the Burroughs operating system that monitors the host's operation.

MCP: See master control program.

Message: A logical unit of information passed between end users.

MSNF: See multisystem networking facility.

Multidrop: See multipoint line.

Multipoint line: A single communications line that directly connects several network nodes.

Multisystem networking facility: An optional program product that allows interconnection of multiple domains in an

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> "Phase III allows terminals to communicate with remote nodes as if there were an interconnecting line between them."

with other nodes that may not be directly connected. Routed packets may be directed through up to seven intermediate nodes to get to their final destination node.

Packet-routing decisions are based upon a static cost matrix maintained in the transport layer. They remain constant unless there is a change in status of one of the nodes or communications lines involved with the session's explicit route.

When routing decisions involve more than a single node, the cost is computed as being the sum of the transmission costs from the node which has the packet to its destination node.

The network management layer allows Phase III network operators at one node to monitor loads, error rates, node and line conditions throughout the network. The operator may then use the information to manually alter the cost matrix contents upon which the routing decisions are based.

Phase III also supports autodial facilities and network command terminals, which allows terminals to communicate to remote nodes as though there were a direct interconnecting line between them.

DEC separately supports both a

SNA network.

NAU: See network addressable unit.

NCCF: See network communications control facility.

NCP: See network control program.

Network addressable unit: An SNA addressable unit that is the source or destination of all messages. Logical units, physical units and SSCPs are all examples of NAUs.

Network architecture: A formalized definition of the structures and interactions required to provide shared communications functions.

Network communications control facility: Along with the NPDA, this program product allows for the monitoring of a complete SNA network from a central location.

Network control program: The program residing in an IBM communications controller that performs all routing, line control and buffering functions for the communications lines for which it is responsible.

Network file transfer utility: The operator interface in a DNA network that performs all internetwork file transfers.

Network Information and Control Exchange Protocol: In Decnet Phase III, these protocol messages pass network configuration information between the nodes.

Network operations support program: A program product that allows an SNA operator to extend his control of the network to include multiple domains.

Network problem determination application: A program product that, along with NCCF, allows for monitoring an entire SNA network from a single location, collecting statistics and isolating communications faults.

Network services: 1) The component of the function management layer in an SNA-defined network that provides configuration and maintenance services, 2) a sublayer of the logical link layer in Decnet Phase III that produces the NSP packets from the DAP messages; 3) in a BNA network, the layer that provides physical access to the network itself.

Network services manager: Controls each layer's operation in a BNA network.

Network services protocol: DNA messages that have information for routing of packets appended to them.

Node: A placed in the network where some intelligence is provided so that communications processing may be performed.

Nosp: See network operation support program.

NPDA: See network problem determination application.

NSP: See network services protocol.

Open System Interconnection Reference Model: A seven-layer model defined by an ISO subcommittee (TC97/-SC16) as a framework around which an open system architecture may be built.

OSI: See Open System Interconnection Reference Model.

Packet: A single unit of information that is passed between adjacent nodes. A single logical message may be carried by a series of many packets and short messages may be combined into one packet.

Path control: An SNA layer that routes messages between nodes and manages parallel links, classes of service and flow control between nodes.

PDN: See public data network.

Peer protocol: In a layered system, the interaction between corresponding layers.

Physical link layer: The DNA layer that manages the actual message transmission over a physical communications line using DDCMP protocol."

Physical unit: An SNA addressable unit that represents a node's physical hardware.

Physical unit services: Elements in the function management layer that make up the services associated with a physical unit.

Port level: Provides access to the network services layer in a BNA network.

Presentation services: 1) An element of the function management layer of an SNA node that maps messages into some required format; 2) a layer of the OSI that maps data between formats.

Public data network: A common-carrier communications facility that allows users to transmit packets to a control unit which transports the packet to its destination user over a high-speed communications network in a cost-effective manner.

RAMP: A single loop-back test diagnostic package provided by Decnet.

Router level: Provides the routing function in a BNA network.

RS-232: An electrical connection standard established by the Electrical Industry Association (EIA).

SAI: See subarchitectural interface.

SDLC: See Synchronous Data Link Control protocol.

Session: A formal binding of two addressable units in a network so that they may communicate with each other.

SSCP: See system services control point.

Station level: The layer in a BNA network that oversees the transmission of packets in the network.

Store-and-forward: A method of passing messages along a series of nodes. Each node, upon reception of a message, will store it and either process the message or pass it to the next node in the series.

Subarchitectural Interface: Manages the transmission of messages over the communications lines in a DCA network.

Synchronous Data Link Control: The IBM protocol used to pass information packets over a communications line. It is like the unbalanced normal response node of HDLC.

Systems Network Architecture: A total communications structure defined by IBM.

System services control point: The addressable unit in an SNA domain that provides overall maintenance of the domain.

Tcam: See Telecommunications Access Method.

Telecommunications Access Method: One of the IBM access methods through which programs may access an SNA network.

Termination environment: Interfaces the user of the DCA system to the communications system.

Termination system: Provides logical access to the termination environment in a DCA system.

Topology: Describes how the network nodes are physically connected in a specific network.

Transmission control: The layer that controls sessions and manages communications in a common network of an SNA network.

Transmission facility: Consists of the communications lines and the SAIs used to manage them in a DCA system.

Transmission subsystem: A collection of the lower SNA layers that provides a common communications network to the higher layers.

Transport network control: Moves messages between DCA systems over the communications lines.

UDLC: See Universal Data Link Control protocol.

Universal Data Link Control protocol: The packet protocol developed by Univac to allow packets to be passed over a communications line.

Virtual Telecommunications Access Method: One of the IBM access methods through which programs may access an SNA network. It was especially designed to support IBM packages such as IMS or CICS.

Vtam: See Virtual Telecommunications Access Method.

WFL: See work flow language.

Work flow language: Defines the environment and the resources required for a task to run in a Burroughs system.

X.21: An electrical connection standard established by the CCITT for synchronous communications methods.

X.25: A three-level peer communications protocol defined by CCITT. It was built using the existing standards for X.21 and HDLC for the lower level protocols.

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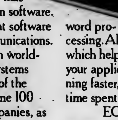

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> **"It can be assumed that DEC's SNA package and its ongoing Ethernet development efforts will tie into Decnet for a complete networking concept."**

package for IBM's Systems Network Architecture (SNA) and a separate X.25 public data network package.

These packages can presently be accessed only by remote nodes through Decnet's task-to-task communications facilities. The SNA protocol package allows DEC machines to emulate an IBM 3790 cluster controller so that they may connect to an SNA network.

DEC has begun to develop more specific X.25 modules for the Decnet layers, which would allow for the direct connection of a Decnet node into X.25 communications systems. At session initiation time, the parameters for the session would be set to direct all transmissions to either the DDCMP or the X.25 data link element.

These additional modules are to be included within the next release of Decnet, which is scheduled for release in early 1982. It can probably be assumed that DEC's SNA package and its ongoing Ethernet development efforts will eventually directly tie into Decnet to provide a complete networking concept. In addition, Phase III includes utilities that allow remote terminals to pass messages between themselves in a dialogue format.

SNA Structure

SNA was introduced by IBM in 1974. Prior to the introduction of SNA, IBM supported more than 200 communications products using 35 access methods and 15 different protocols. We can expect future IBM communications product development efforts to revolve around these SNA concepts.

In SNA, the applications access to the underlying network is managed through either the Virtual Telecommunications Access Method (Vtam) or the Telecommunications Access Method (Tcam). The access method is supported by connections to a 370X communications controller running the network control program (NCP) or may be resident in an IBM 370 mainframe. The NCP controls and monitors all communications lines connected to it, performing such tasks as polling, addressing and buffering, as well as communications line error detection and correction. It frees the host from much of the overhead associated with data communications.

SNA was originally defined for a single-host system; but with the introduction of the Advanced Communication Function, multisystem networks became implementable.

SNA consists of the Common Transmission Network, which does the actual message transfers over communications lines, and a series of half-sessions, which are ports through which the end user may access the network. The Common Transmission Network can be further broken down into path control and data link control layers. Each half-session element consists of function management, data flow control and transmission control layers.

The Function Management Layer consists of presentation services, logical unit services and physical unit services.

Presentation services are used to map messages into a device-independent form. The degree of the mapping can by dynamically altered, allowing the end user to handle a part of the actual mapping if desired.

Logical unit services allow end users to create and receive messages with a system service control point (SSCP), to pass messages between themselves and perform various network services.

Physical unit services provide interfaces between the units themselves and between the SSCP and the physical unit itself so that network ser-

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"Session control allocates and deallocates system resources upon receiving session establishment or termination requests."

vice requests may be carried out. The class of network services performed by the SSCP includes: 1) configuration services for the activation and deactivation of logical and physical units as well as control of data links; 2) maintenance services that test and collect information on error conditions and overall network status; and 3) session services that establish network addresses from network names and obtain all required network session parameters.

These session parameters include information concerning the structure of the data and the response type expected. Session control responses can specify that a node will wait for a response to each request, will send many requests before any responses are expected, will send many requests and wait for a response only to the last request or will send requests entirely independent of the received responses. Session node response parameters may be set to specify that the responses must be returned in the order of the requests, that the responses can be returned independent of the request ordering or that responses need only be sent in the case of a detected error condition. Since an SSCP is directly responsible for all the logical and physical units directly within its domain of control, it is the hierarchical root of those physical and logical units.

The Data Flow Control Layer performs all dialog control processing — for example, it can alter session state variables from the "send" to the "receive" state — and it handles chained messages where the user has done some message decomposition himself to conform to the established session buffer limitations. In addition, all end-to-end message flow control is performed by this layer.

The Transmission Control Layer provides network addressable units with access to the transmission subsystem. It contains the connection point manager, session control and network control. The connection point manager builds basic information units by appending, addressing and sequencing information to each message to be transferred. This component contains the processes that create and react to exception conditions as well as data pacing, a method used to prevent the transmission of session messages at a rate higher than the destination node can process them.

Session control is the component that allocates and deallocates system resources upon receiving session establishment or termination requests. Network control aids in notification of the loss of some network services. Some catastrophic error recovery is also done in this component.

The Path Control Layer breaks the messages it receives from transmission control into a series of packets, appends its sequencing information to each packet allowing the messages to be reassembled correctly by the receiving host and appends link addressing information to route the packets to the next node in its explicit routing path. This layer is also responsible for the management of all shared data link resources within the most common network.

A series of data link control elements form the **Data Link Control Layer.** For data link control elements connected by a communications line, one data link control element controls that specific line. In this layer, the Synchronous Data Link Control (SDLC) protocol frames are built for transmission. Transmission errors are detected in these elements and corrected by requesting retransmission of the frames.

Every seven frames, positive acknowledgement of correct reception of the sequence is

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> **"The Advanced Communications Function is the group of IBM program products that accomplishes the SNA networking functions."**

expected, or an error condition is assumed to exist. If an error is detected by the receiving node, it sends a retransmission request to the transmitting node, which halts the present transmission sequence and begins transmitting anew starting with the frame containing the originally detected error. The receiving node may include positive reception acknowledgment information in message frames being sent to the transmitting node in order to cut down on the overhead involved with transmitting individual acknowledgment frames. It is this element which provides flow control services for its physical data link.

Messages created by the end user for transmission are passed to the function management layer, where presentation services maps the message according to the specified class of services into a request-response unit. The connection point manager in transmission control uses the parameters passed to it from data flow control to create a request-response header, which is appended to the request-response unit. This combination request-response unit and header form a basic information unit, which is passed to the path control layer of the transmission subsystem. Path control breaks the basic information unit into packets and appends a transmission header to each packet, forming a set of path information units. This entire set forms a single basic transmission unit.

Data Link Control

In the next layer, data link control, a link header and a link trailer are appended to the basic information unit to form a basic link unit. This basic link

This basic link unit is actually passed to the required protocol transmission element in the data link control layer to be transmitted over the communications line.

Individual SDLC packets consist of an initial framing flag, a secondary station address field, a control field (containing information to maintain line control between adjacent units and manage packet sequence acceptance), the information field itself, a frame block check field and a final framing flag.

The SNA structure defines the end user to be the source and destination of all information. Each end user is represented by a network-addressable unit (NAU), a network resource assigned to that end user with a unique network address.

In the communications system, it is represented by the functions above the transmission subsystem. A network address is a 16-bit string consisting of a subarea and an element specifier. A session is a formal binding of two NAUs that must be established before communications can begin.

There are three types of NAUs: the SSCP, physical units and logical units. The SSCP resides within the host and is responsible for establishing sessions, recovering from component failures and bringing up the network. The SSCP will establish a session with each active physical unit as a part of the network initialization process. Each node defined to the SSCP has a physical unit associated with it. Logical units are the access ports through which the end user can gain access to the network. An end user is any resource that is external to the SNA network.

Three types of NAU sessions are possible: logical unit to logical unit, which allows for message exchanges; logical unit to SSCP, which carries out operator requests and establishes and terminates logical-unit-to-logical-unit sessions; and physical unit to SSCP, which checks and changes the network configuration and status. Multiple parallel logical-unit-to-logical-unit sessions are supported and, in all cases, one logical unit must reside in a host unit.

All sessions are established during a binding process in which session parameters are passed between NAUs. Upon receiving a bind request, a unit may return a session acceptance message, a session rejection message or a set of modified session parameters to be acted upon by the NAU where the session request originated. Once a logical-unit-to-logical-unit session has been established, message flow will generally go through the following layers in the originating node: presentation services, data flow control, transmission control, path control, then data link control. In the destination node, the message will flow through the same sequence of sublayers in the reverse order.

The ACF Group

The Advanced Communications Function (ACF) is the group of IBM program products that does the actual SNA networking functions. Using a recent release of the NCP and Vtam (or Tcam), these programs control communications in single- or multihost networks. In SNA, the SSCP is re-

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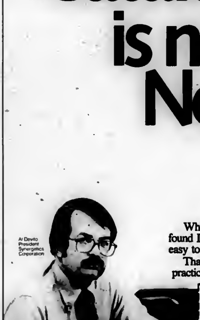

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"SNA uses a modified static routing strategy that assigns routes at session initiation rather than for each message sent."

sponsible for managing all the network services, thereby forcing the individual sessions to be very dependent on the SSCP. Since ACF is built upon Vtam, it tends to force a "tree mesh" or "hybrid peer/hierarchical" structure where each host system in the network is structured hierarchically, but peer-level communications between systems is allowed.

Single-domain networks have a single controlling point in the host, the SSCP, which manages the resources (programs, stations, physical and logical links) defined within that domain. Multiple domain networks have several domains, possibly having more than one reside in the same machine, sharing the same NCP connected by the multisystem networking facility (MSNF) over a cross-domain link between communications controllers. This is done by adding the capability of SSCP-to-SSCP sessions to the list of possible session types.

ACF Capabilities

Depending on which model of the communications controller (370X) is used, up to eight host connections may be made from a single controller. ACF supports both multiple cross-domain links and parallel cross-domain links. Multiple cross-domain links connect different communications controllers in different domains to allow for the existence of multiple paths between these domains. Parallel cross-domain links are a group of transmission lines going between the same communications controllers.

Cross-domain routing may go either between two access methods or between a node and an access method, allowing for resource sharing from a remote system. These functions allow for total job networking capabilities, which is the ability to submit a job from a remote node (remote job entry or otherwise). The network can then route the job to any host within the network for processing and route the output back to the originating node upon completion of processing.

Encryption Support

The ACF functions support IBM's encryption packages, data message compression, automatic answer and polled multidrop communications lines; and ACF is dynamically reconfigurable through operator controls.

In order to minimize the effect of errors, the ACF supports transmission pacing and line and unit backups. This backup system allows for the trial of a new line should the line that a particular session is using fail. Should an entire node fail, an alternate node can be substituted for it. If a host goes down removing the SSCPs that it contains from the system, the SSCPs residing in adjacent hosts are allowed to assume control of the domain's resources previously held by the SSCPs in the downed host.

Also by allowing the remaining SSCPs to go across the domain links, through the communications controllers, the logical and physical units held by the incapacitated system are not effectively removed from the network. In all cases, the host application program and the network operator are informed of any changes in the status of the connection within a session. In addition, statistics collection, physical link test, message trace, buffer and message dump diagnostic facilities are also provided.

Routing Strategy

SNA uses a modified static routing strategy based on explicit routing. This strategy assigns routes at session initiation rather than assigning a route (possibly different) for each message transmitted.

To initiate a logical-unit-to-logical-unit session, a logical-unit-to-SSCP session is first established by an operator or a sysgen command. The SSCP uses the class of service information and symbolic network names, which are converted to physical network addresses to assign a virtual route. The class of service is used to indicate the type of traffic a session desires (such as interactive fast response, batch high volume, high security, high reliability and so forth).

There are four transmission priorities: low, medium or high, which can be specified by the user, and super high, which can be specified for certain system messages. The virtual route is used to select a physical path from a set of possible paths defined by the network manager. A maximum of eight physical paths may be defined between any two logical units, which limits users to acquiring one of 24 priority virtual paths from the information supplied in his JCL. The intervening SSCPs also assign each virtual path to an explicit path, which results in an ordered sequence of domains to be traversed by the transmitted packets.

Session transmissions will continue over the same explicit path, passing

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> **"A large number of vendors offer a wide range of data communications equipment as a viable alternative to IBM products."**

only through the intervening communications controllers, independent of host control. Should an error be detected, a new explicit path may be assigned to the virtual route by the SSCP.

Multiple parallel lines between the same communications controllers form a transmission group and are treated as a single logical link. Packets sent over these transmission groups are dynamically distributed among the lines. Should one of the links in the group go down, the message traffic is redistributed over the remaining links in the same transmission group. Once the originating SSCP receives approval of a requested session establishment, message transfers between remotely located logical units do not require host intervention to complete message processing.

Flow Control

Flow control oversees the manner in which messages are sent to a remote unit. A part of this section assures that a remote unit does not receive data at a rate higher than it can be processed. This is accomplished by altering the size of a transmission window which specifies the total number of unprocessed messages that are allowed between nodes at one time.

Permission to transmit these messages must be requested by the transmitter and may be granted or limited by the receiver depending on the available buffer space. Multidrop transmissions are also handled by data link control through use of a table-driven controller to poll the first station, on a line according to a user-defined station ordering, for messages. When that station has completed transmitting, it polls the second station in the ordering.

When the host receives the poll itself, it transmits its messages, which are handled in a store-and-forward manner between stations. Broadcast transmissions allowing a single message to be directed to all stations on the line are also supported. After the host has finished transmitting its messages and completed the polling cycle, the cycle is repeated.

Interconnected Network Support

Although SDLC is a functional subset of High-Level Data Link Control (HDLC, the communications packet protocol used by X.25), SNA's path control is entirely incompatible with X.25's packet layer. Therefore, to connect with an X.25 network, IBM would either have to use a "black box" between the SNA and the X.25 network, rewrite sections of the path control section in SNA or build a network gateway. If boxed protocol conversion units are used, as changes are made to X.25 and the other standard networks, the units themselves will require alterations and enhancements. This could prove to be very expensive and troublesome for both IBM and its users.

None of these solutions to obtaining access to an X.25 network is very appealing. An X.25 black box translator has been offered to SNA users in France and Canada so that they may connect with the Transpac and Datapac PDN; however, the product has met with resistance from the customers in these countries because of their substantial cost. This lack of any desirable interface would prevent SNA users from connecting the Advanced Communications Service (ACS), a public data network presently being developed by AT&T which will apparently use ISO or X.25-type connections, GTE's rapidly expanding Telenet service or any other X.25-compatible network.

A large number of vendors offer a wide range of data communications equipment that provides a viable, cost-effective alternative to IBM trademark equipment. Since SNA products require a much higher level of interaction between hardware units, outside vendors initially had a difficult time developing units of similar complexity that can interface with an SNA network. A major advantage to SNA, from IBM's point of view, was that it protected IBM from the rapidly expanding plug-compatible market. As SNA becomes more understood by these outside vendors and the user community on the whole, IBM's clear present advantage in the field will continue to decline.

Although IBM has publicly stated its support for OSI standardization efforts (described further on) several times, it appears as though it will not offer such services to its users until it must. It will require quite some time for the full standards to be ratified, accepted by the public and then made available directly through IBM. This will serve to further undermine IBM's current position in this particular area of the marketplace.

IBM also has a network operations support program (Nosp) and a more recent replacement for Nosp, the Network Communication Control Facility

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"Burroughs Network Architecture was originally announced in 1978. As of early '81, it has yet to be released."

(NCCF), which contains routines that allow user programs to sense and react to network traffic conditions. The NCCF also allows network operators to control domains other than their own. The network problem determination aid (NPDA) allows operators to isolate and monitor error occurrences from a single central location.

Burroughs Network Architecture

Burroughs Network Architecture (BNA) was originally announced in 1978 and is still under development by Burroughs Corp. (It was scheduled to be released to the public on the B6000 systems series sometime in late 1980; releases for the remainder of the Burroughs line were scheduled to be staggered through 1982). As of early 1981, BNA had yet to be released, and therefore the discussion presented here is based on prerelease product information and may change prior to general release.

BNA consists of two major layers — the host services layer, which provides logical access to the communications network, and network services, which provides physical access to the communications system. Network services can be broken down further into three distinct levels: port level, router level and station level.

Host Services provides the user with a transparent interface to the network system by making use of an enhanced version of the Master Control Program (MCP). The MCP is the monitor and control interface to the host's operating system.

The Port Level contains several system ports and a port-level manager. The port-level manager allocates and deallocates the ports as requested and manages port addressing. The ports provide individual access to the network services layer and the underlying network by the host services layer. It is this level that is responsible for the breaking up of a message into a series of packets, the coordination of message ordering and the chaining of a series of messages.

If **the Router Level** receives a packet from a station module in the Station level that is destined for another remote host (store-and-forward packet transfers), or receives a packet from a port module that is destined for another remote host, then the packet is routed in this level to the correct input queue of one of the station modules. If the packet came from a station module or a port module and is addressed to the local host, the router will place the packet in the input queue of the correct port module in the port level. The router manager, which is contained in this level, controls a table of active hosts used to determine the required routing information.

The Station Level consists of a series of station modules, each of which manages a physical interface between adjacent hosts. The modules may transmit via either Burroughs Data Link Control (BDLC) protocol or X.25 (using HDLC version LAP-B)-type packets over synchronous, asynchronous communications lines or through shared global memory between the systems. The station module will check each received packet for errors, requesting retransmission of a packet upon detection of a transmission error.

A station level manager within the station level allocates and deallocates the station modules and coordinates the passing of packets between the router and each specific station group module. Multiple parallel links (between the same host) are treated as a single logical link, and packet transmissions are balanced between the lines by the station level manager.

The network services manager is a module that can pass control messages generated by a network operator or the network itself to any logical level within the system. It produces control messages to do network initiation, host validation and system monitoring. At initiation, a host will pass its logical name to all other hosts operating within the network. The remote hosts will return their name to the initiating host upon acceptance of the new network node.

Since the table of active hosts is maintained dynamically, there is no need for the hosts to keep a static system directory of all the hosts physically attached to the system. If the station level detects a link or node outage, it submits notice to the network manager of the condition, which initiates corrective action.

Host services will normally create a message field and a function indicator to be passed to the host services layer in another system. The function indicator includes the various parameters of the message such as whether a response or acknowledgment is expected, if the message is a logical part of a series of messages (chaining) and/or actions to be taken upon the detection of a network error. This combination message and indicator is passed to a port in the port level.

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"Univac plans to orient all future enhancements in DCA toward the ISO standardization efforts."

The port will break this information into a series of packets and append information to each packet to create a new series of packeted port information units which are then passed on to the router. The router will add further information, creating several router information units which are passed on to the station level. The station module in the station level that receives the packet will add more information to the packets in order to create link information units; these packets are physically transmitted on the network communications facility. Control messages may also be created in any layer and passed on to an equivalent layer in another host unit.

BNA Capabilities

BNA will be supported at various levels over most of the Burroughs line (B80 through the B7800), allowing the larger systems to make optional use of the Data Communications Processor (a front-end communications processor) to remove much of the communications processing overhead from the main CPU.

Initially it will only define the interaction required between host systems in a peer-to-peer relationship, but the concept will be expanded to include remote-terminal-to-local-host interactions as well (in direct contrast to IBM's SNA evolution).

It supports full remote I/O file access, allowing for remotely requested read, write, create and delete actions which can be acted upon by the remote host depending on the restrictions imposed on the user.

There are special extensions which have been added to the library maintenance procedures to allow for file transfers within the network as well.

Task-to-task communications are accomplished by allowing each task to define a temporary file which is referred to as a port file. Access to these port files is shared between tasks, allowing messages to be passed through the files. These port files are accessed by the end user in the same manner as local files would be. This concept of port files makes the building of network applications a very natural procedure for the user.

The Work Flow Language (WFL) compiler has the capability to pass entire jobs through the system to a specific remote node upon request. Additional facilities are provided to allow complete jobs to be remotely initiated and controlled, to allow local terminals to logically attach themselves to a remote host and to allow network operators to make network inquiries and to dynamically alter the network environment.

Since either BDLC or X.25 protocols may be used, connections of a BNA network into an X.25-compatible public data network or an X.25 network are supported as well.

Since the majority of Burroughs' products are aimed towards the commercial/financial market, future BNA developments will probably include local networking connections and a stronger network security system. These added capabilities would make it desirable to include office-of-the-future and electronic funds transfer applications within the BNA network.

Univac's DCA

Sperry Univac introduced the Distributed Communications Architecture (DCA) in November 1976 and released a major revision in June 1979.

DCA allows use of a Distributed Communications Processor (DCP) as either a front-end communications processor, a remote concentrator or an individual nodal processor (connecting to other DCPs). These communications processors remove the communications overhead from the CPU, but are not an absolute requirement, thereby allowing smaller processors in the Univac line, which cannot handle such a processor, to be added to the network. When these DCPs are used, they run the Telcon program package; and the host runs either the Communication Management System (a special-purpose Univac 1100 telecommunications access method) or the Virtual Integrated Communications Access Method (Univac 90).

Univac does plan to orient all future enhancements in DCA to push towards the ISO standardization efforts.

The Logical Layers

The DCA system can be divided into two different environments: the termination environment and the communications system. The communications system handles all intersystem communications, while the termination environment interfaces the user to the communications system.

The termination environment can be subdivided into the management environment, the applications environment and the termination system. The communications system can be subdivided into transport network control and the termination system. The termination system resides in both the termination and the communications environment, providing the interface between the two major levels. Transport network control is responsible for the movement of messages between the systems. It consists of a series of transmission facilities and transport network control modules.

The Application Environment consists of all tasks and applications that make use of the communications system. All messages originate and are destined to the applications environment. It consists of several communications system users and end users. A single communications system user and its associated end users form an application system.

The communications system user provides an interface to the termination system as well as control- and relative-addressing assistance for a group of end users. End users refer to other end users by an end-user ID which is transformed by the communications system user to a logical port address. Since addressing is only relative to each communications system user, there is no need to ensure that each end user has a unique network-wide address. The end users are individual program segments, devices or operators with some common references between them (such as through a data base management system); they are the sources and sinks of all information sent through the network.

The Management Environment contains application management services, the communications systems administrator and network management services. Applications management services controls the termination system and manages the connection between the applications environment and the communications system by handling all actions to initiate and terminate sessions, monitor sessions and maintain session activity. Network management services controls the transport network within the communications system.

In nodes using a DCP, the network management services function physically resides within the DCP; therefore, if the host fails, the network running through the DCP would still be able to remain functional. The communications system administrator provides commands to act on reconfiguration requests. These management services may be omitted from a local node if a remote node's range of control has been extended to include the local node in question.

The Termination System contains several logical ports (one for each communications system user) and a logical port multiplexer. Each logical port contains flow control and presentation services modules. Logical port flow control regulates the flow of messages so that neither logical port involved in a session will exceed its buffer limitations. The logical port presentation services function transforms the data addresses and the control information it receives to a form the transport network and the destination logical port can use. The logical port multiplexer manages the flow of messages from all logical ports to the transport network and from the transport network to the logical ports.

Transport Network Control consists of three sections: data unit control, route control and trunk control.

The data unit control section manages the logical connection between the termination system and the transport network control layer. All logical errors (such as loss of messages), data assurance, data unit flow control and a further relative address transformation is done by this section.

The route control section does the actual packet routing between nodes. Routing can be specified in two ways: 1) it can be set at session initiation and remain constant as long as no transmission facility outages are detected; or 2) it can be dynamically routed on a per-message basis according to the load on the transport network when the message passes through the trans-

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"Many people have been given the impression that the ISO model is a de facto standard. This is not at all true."

port network control layer (this method requires much more communications overhead because of the number of control messages that must be transmitted through the system). There are several trunk control sections in the transport network control layer, one for each logical path and subarchitectural interface in the transmission facility between two transport network control units.

The trunk control section is responsible for managing multiple parallel links, including balancing the packets transmitted over them.

Transmission Facility

The transmission facility consists of either two cooperating subarchitectural interfaces (SAI) connected by some communications line or of a queue used to pass messages between processes in the same machine. The SAI manages the physical line interface and performs the line initialization, recovery and transmission queue management tasks. Line transmissions can be Universal Data Link Control (UDLC) protocol, SDLC protocol, Bisync protocol or X.25-type protocols over synchronous or asynchronous lines or, alternatively, channel protocol over a communications channel.

Three types of sessions are supported by DCA: 1) system sessions that go between end users through a common communications system user; 2) logical port sessions that go between users sharing a common termination system; and 3) transport network sessions that pass messages through the transport network.

In a transport network session, a communications system user in the application environment will build a user data onit for an end user and pass it to a logical port in the termination system. The termination system will combine or partition the messages it receives, according to its buffer limitations, to form port data units. The transport network uses the port data units obtained from the termination system to build network data units, which are segmented and then transmitted over the communications line by the SAI.

The system sessions and logical port sessions only require information to be passed within a single node. These session types are treated as a transport network session, except that their messages are directed back through the system rather than through the termination system.

DCA provides facilities for the collection of statistics on performance, for system status verification, error tracing and logging. Multipoint communications and store-and-forward routing have been implemented, allowing node access to any other node residing in the network. It also allows for the dynamic reconfiguration of the system and allows for network confidence queries to verify the network status, which are initiated on the detection of a network error or upon operator request.

Univac also supports the addition of an Adapt program product into the network software. Adapt allows users to define their own communications protocol to support unusual communications needs. Logically, an Adapt is a combination communications system user and an end user performing a complete special-purpose transformation function.

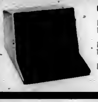
DCA also provides complete surveillance and access control mechanisms to aid in the development of a secure network (including encryption and audit trail facilities).

OSI Reference Model

Most network architectures have little in common as they were designed aroond very different machines from very different perspectives. In 1977, the ISO created the Open Systems Interconnection subcommittee (OSI SC16) to develop an open system interconnection reference model that can serve as a framework around which a series of standard protocols could be defined.

In July 1979, the OSI passed the seven-layer model it had decided upon to its parent organization, the data processing committee of the ISO, so that it might use the model as a basis for beginning the actual standardization effort. (It should be noted that CCITT is moving towards developing a separate seven-layer architecture as well. There are major functional differences between these two seven-layer systems.)

The intention of the open system architecture is eventually to allow any system conforming to its protocol standards to connect and communicate messages according to application-defined protocols. Many people have been given the false impression that the model is a defacto standard in itself or that some portions of it are already accepted ISO standards. This is not at all true. The ISO model is simply a communications reference model, not



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"Although the ISO model contains seven distinct layers, it can connect with any other system adhering to its protocols."

a standard, not even the specifications for a complete networking system or architecture.

Although interfaces for each layer will be well defined, no effort is implied toward developing any distributed operating system functions, such as resource sharing or network monitoring; these functions may be supplied above the message communications system. Since so many vendors publicly support the standard development work and appear to be aiming their communications packages in that general direction, the OSI reference model provides an excellent beginning point of reference from which one can relate the previously presented architectures.

The Logical Layers

OSI's reference model can be broken down into seven layers.

The lowest layer is the physical layer, which maintains the physical connection between communicating systems.

Level two is the data link layer, which administers the passage of all information over the physical connections.

Layer three is the network layer, which administers the routing and transmission of all messages between communicating systems.

Layer four is tha transport layer, which establishes and maintains the logical end-to-end message transfers.

Layer five is the session layer, which supports the logical sessions between two end users.

Layer six is the presentation layer, which provides all information mapping services.

Finally, layer seven is the application layer, which represents the end user to the system.

It is important to point out that the reference model only formalizes the systems' apparent behavior and protocol requirements; it does not force any particular implementation structure directly on the developers.

Layers one, two and three will probably be defined similarly to CCITT's public data network X.25 communications protocol standards. Layers four through seven form the rest of the communications architectural model. Although no specific standards exist for these upper layers, several specific proposals are presently being developed.

It is important to realize that although the model is defined as containing seven distinctly behaving layers, it can connect and function with any other system adhering to its protocol behavior, no matter how this other system is conceptually divided.

The Physical Layer

This level details the characteristics of the physical communications interface between the system components. Something close in form to the X.21 standard (the physical layer standard recommended by X.25) will probably be used as the basis of the standard to interconnect the communications units. These or other existing standards (such as RS-232, RS-449, V.24 or V.25) could be very easily worked into the OSI model specifications.

The Data Link Layer manages the error-free transmission of frames between nodes in the system. HDLC packet protocol already exists as an accepted, popular protocol ISO standard and as such will probably be incorporated as a part of the OSI standard. With the balanced version (LAP-B), which is preferred by CCITT, both stations at the ends of the communications line share packet transmission and recovery responsiblity; neither station operates in slave mode. The Link Access Protocol (LAP) was the earlier nonbalanced version of LAP-B, which was designed for use in polled multipoint systems. This layer provides error checking of all received packets. A frame found to be in error according to the block check sequence contained within each frame causes a request for retransmission of that frame and all following frames.

The Network Layer provides services which transport data through the network to its destination node. The control messages created by this layer include line connection and termination requests and message confirmations. Packets are created from messages routed through the network in this layer. If a packet destined for another node is received, this layer reroutes the packet back down through the lower layers.

X.25 is the first internationally recognized data communications protocol, and as such, an expanded form of X.25 stands the strongest chance of being accepted as the network layer standard. However, it will have to be significantly enhanced to meet the full OSI model recommendations. (X.25 only defines the requirements of a connection between some data termination equipment and a public data network; it is not a standard connection between sets of data communications equipment.)

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"All vendors offer a choice of physical layer connections to the network including X.21 and RS-232 standards."

The Transport Layer provides tha facilities to ellow end users to pass messages between themselves ecross several intervening stations in a cost-effective manner oblivious to the natwork limitations imposed by the lower architectural levels. It includes fecilities to do all user addressing, date assurance and flow control.

Further, the final specifications may possibly include facilities for broedcast transmissions, detagram services, eccounting information collection and specification of e subset of session managamant services es well. Tha lavel of service mey indicete session priority, security, en acceptable error rate, responsa time expectations and a recovery stretegy.

The Session Layer is responsible for initiating, maintaining and terminating each logical session batween end usars. In addition, this layer is responsible for menaging and structuring ell session-requested data transport actions. Session initiation should arrenga e contractual agreement for all tha desired end required services between session perticipants. Session termination provides an ordarly way to terminata a praviously esteblished session end provides services to premeturely abort e session, should this become necessary.

The Presentetion Layer performs a selectable set of messaga trensformetions and formetting for menegement of user buffars and equipmant such as printers end CRT screens to present dete to the end users.

The Application Layer is tha and user's access to the network. End usars communicata by passing epplication dafined protocol messages between themselves vie the lower layers. Many of tha menagement functions such as remota system initietion end termination, network monitoring and diagnosis and reconfiguration ara considared as special case application processes by the OSI model. Thesa functions ere granted direct access to any of the model's layers.

Layer One Equivalents

All the vendors discussed offer e large choice of physical layar connections to the network including X.21-type and RS-232 stendards. Tha severel line interfaces evailable allow a wida range of transmission rates over synchronous or asynchronous transmission lines. Tha DCA network specifically included tha physicel layer within tha transmission facility, and in SNA these servicas ara implied by tha data link control leyer. In DNA Phase III, tha communicetions fecilities heve been included within the physical link layer; however, they were not so defined undar Decnet Phase II. BNA tends to viaw thesa services as in the realm of supporting hardware rather than es e direct part of the network.

Layer Two Equivalents

Tha data link layer specifies the fecilities for frame transfar between two network nodes. Its functions are contained within tha transmission facility's subarchitecturel interface of tha DCA network and from the station laval, data link control end the physical link layar in BNA, SNA end DNA networks respectively. Only the DCA and BNA natworks support tha HDLC protocol.

SNA's SDLC frames form e functional subset of HDLC as it supports only tha unbalanced LAP normal communications moda. DEC's DDCMP is an entirely different type of protocol from HDLC (a byte-oriented protocol thet contains data field length specifiers rather than a bit-orianted protocol which mekes use of uniqua flags to indicata tha deta fields position).

The network layar functions form DCA's trensport natwork control layar and part of SNA's path control layer. BNA's router layer, along with a small part of tha port layer, provides the functions of the packet layer. The transport layer, which was contained within logical link layer undar Phase II, end a portion of the session control/network services layer perform tha DNA functionally equivelent functions of tha packet layer in the ISO modal. In 1977 IBM introduced a separate line adapter to allow French and Canadian users to connect simple logical units (such as tarminals or printers) to an SNA natwork domain through en X.25-compatible PDN. IBM hes yat to decide if a functionally equivalent unit will be offered to users within the U.S.

High Layer Equivalents

Tha functions of tha transport layer and the presentation layer are provided by the termination system; the session control layer by the communications system in the epplication environment; and tha applicetion layer by tha end user layer in the application environment in a DCA network.

In e BNA network, the majority of tha port level provides the transport and session control layer services. Host

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"Unless standards are developed, each vendor will have to provide modules for connection into another vendor's network."

services provides presentation and application layer services in a BNA network.

In SNA the transport layer functions are contained within a portion of path control and transmission control; the remainder of transmission control, data flow control and part of the function management layer provide the session control layer services; the rest of the function management layer provides the presentation layer services and the application layer services.

In a DNA network, the user layer provides the application layer services and the network application layer provides the presentation level services (both were formally contained within Phase II's dialog layer). Session control and network services (previously contained in Phase II's logical link layer) include transport and session control layer services.

Open Systems Future

The International Standards Organization's long-term objective in working with the OSI modem was to form some intersystem networking capability standards. Unless such standards are developed, each vendor wishing to unlock the door and allow for an integrated internetwork connection into another vendor's network would have to provide a complete individualized set of modules for each such interconnection desired. This seems to be exactly what DEC would have to undertake in order to develop a set of Decnet-SNA interconnection layers.

Because of the large time delays involved in formalizing and gaining approval of an Open Systems Standard from the reference model, it appears that this is the path most vendors will be forced to take, if they wish to allow nonstandardized network interconnection facilities.

Even when the standard has been approved, the majority of the vendors must support it and develop their products around it before the proposed architecture standard becomes of any practical use to the network user community as a whole.

The U.S. National Bureau of Standards is presently in the process of specifying a set of federal networking standards. Its work is being strongly coordinated with standards activities and private enterprise. An overview of the NBS computer networking program is available from the Systems and Network Architecture Division, National Bureau of Standards, U.S. Department of Commerce, Washington, D.C. 20234.

Anyone interested in doing network development would probably be interested in obtaining this basic description of their work.

Comparison of Key Issues

As the network architectures discussed in this article are so vastly different, a meaningful, in-depth technical comparison of the complete systems would probably be limited in scope or extremely biased and therefore not very practical. Several distinct key implementation issues may be contrasted, however, to gain a better understanding of the different philosophies used in the development of the architectures. The hardware used, the transmission protocols and the routing decision processes are among such key issues, as they play a major role in determining the networks' overall characteristics.

Hardware. With the introduction of Decnet Phase III, DEC removed its adjacency constraint; thus, none of the vendors discussed place any major limitations on the topology of the network. DNA and BNA both are implemented at various levels over most of the DEC and Burroughs product line. On the other hand, while IBM allows its low-end processors to connect an SNA network under the direct control of a larger host, both SNA and DCA allow only their high-end hosts to be root nodes in their hierarchical networks. (Although the 8100, the apparent base for most of IBM's distributed office-of-the-future development work contains an SSCP and can function as a stand-alone unit, when communicating with a host system, the 8100 simply functions as a sophisticated cluster controller subordinate to the host system).

To prevent the communications functions from overloading a host, both of these vendor architectures and BNA make use of front-end communications processors. In any network node where there is a high volume of communications traffic, such a front-end processor is almost a necessity.

Transmission Protocols. Only the transmission protocols have been chosen for comparison purposes as, given their low level in the architecture, all transmissions make use of them. In addition, since the higher level protocols are so complex, they are much more difficult, if not impossible, to accurately contrast.

Of the transmission protocols, all but

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> **"None of the network architectures make any allowances for building a multivendor network."**

DEC's DDCMP are very similar in nature to HDLC. DDCMP is a byte-oriented protocol; information transparency is gained through use of a data length specified rather than bit stuffing. The other protocols (SDLC, UDLC, BDLC and HDLC) are bit-oriented protocols, making use of flags to determine the length of the data field (transparency is obtained by inserting bits into the data field upon transmission and deleting them upon reception; this guarantees a unique flag occurrence). The HDLC packets carry a total of 24 bits of control information with each packet, compared with the 96 bits carried with the DDCMP packets. These extra bits carried by DDCMP include an extra block check field, the data field length specifier, and also allow for a greater number of unacknowledged packets to remain outstanding.

All of the mentioned protocols require that the reception of each frame be acknowledged; if not, some transmission fault is assumed to exist and corrective action is taken. HDLC-type protocols require positive acknowledgment only every 256 packets. (HDLC does have an expanded format that requires acknowledgment of a frame only every 127 frames; however, this option is not always implemented by the vendors.)

Simulation of error-free transmission over half-duplex lines indicates the HDLC protocols add less total communications overhead to the communications lines and, therefore, the ratio of data to control information is greater. The introduction of transmission errors and allowing full-duplex transmission make HDLC's advantages over DDCMP more apparent. DDCMP would only become a more favorable protocol when long communications delays enter into the system (such as when passing information over long distances or over a slower communications medium).

Routing Decisions

All the vendors described use some form of a shortest path algorithm with variations in the cost assignment to each communications line. All the algorithms are adaptive in that they alter themselves dynamically to account for lines that have failed.

DEC and Burroughs network architecture routing decisions are made in a similar manner. Each system maintains a routing matrix containing information that describes the system's physical line interfaces and a weighting factor. In BNA the weighting factor is determined by the performance characteristics of the system connected by that specific line and the line itself; in DNA the weighting factor is determined by the network manager. In both cases, the weights can be altered to reflect changes in the network performance.

Both IBM and Univac allow for the selection of a message route at session initiation according to the services required of that session from a table of predetermined possible paths. This route is then fixed for the duration of the session unless a communications fault that inhibits communications is detected; should this occur, a new route is immediately requested. In addition, Univac also allows the user the option of specifying that each packet passed through the system during a session be dynamically routed according to the network's conditions at that time.

An Ideal System

Previously, an ideal general-purpose distributed processing system was described as having certain characteristics to make it as easy as possible to use and to make the network extremely flexible. None of the network architectures described make any allowances for building a multivendor network. Since Decnet limits store-and-forward message passing to going through no more than seven intermediate nodes, it does place some topology restrictions on the network. SNA's hybrid peer-hierarchical structure also places some limitations on the network structure; however, this could be argued as being a desirable restriction.

All the described networks free the user from having to know the exact network structure; they detect and act on errors, have been implemented in a layered form and allow task-to-task communications. In most cases, the control procedures required of the user are minimal, and the devices can be accessed independent of their location.

Other Network Architectures

Virtually all vendors have recognized the importance of distributed data processing in today's marketplace. A number of other network architectures are briefly outlined below to provide a more rounded perspective of some other vendors' current activities in the area of distributed processing. Although there are other networking packages available, only those with a

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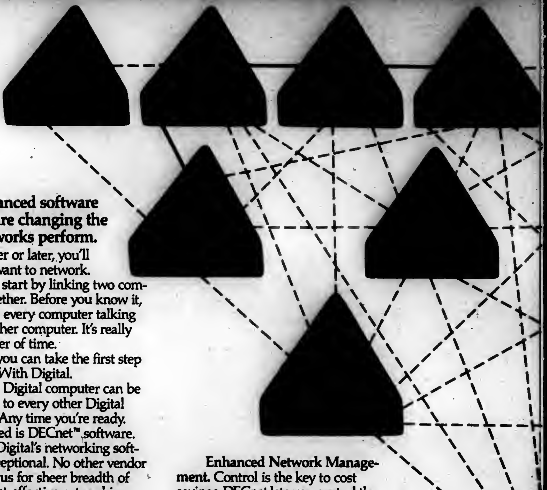

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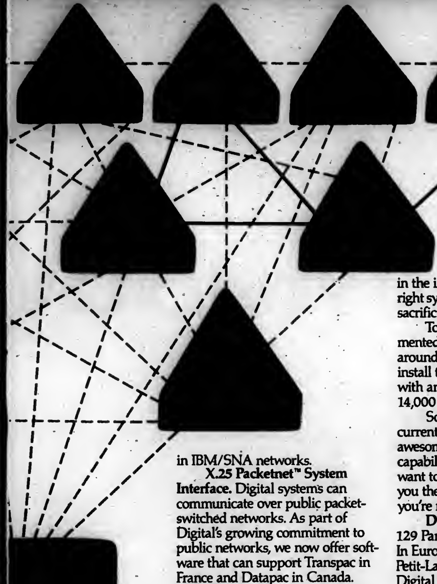

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"Since NCR acquired Comten, its software communications products have begun to migrate toward full IBM compatibility."

strictly defined architecture and sufficient available printed material have been covered. Any possible omissions of a particular vendor package are purely accidental and not meant to slight that vendor.

DNA (NCR)

NCR Corp. introduced its Distributed Network Architecture (another DNA) in June 1977.

NCR's DNA operates through two main software modules, the Telecommunications Access Method (NCR/TAM) and the Data Transporting Network (NCR/DTN). NCR/TAM provides all queuing and address transformation functions. NCR/DTN consists of three separate logical layers: (1) communications system services, which manages all message-passing between systems by breaking messages into packets and passing them in a controlled manner to the route manager; (2) the route manager, which routes each packet dynamically through the system; and (3) the data link control layer, which then builds transmission packets according to either Bold (NCR's protocol), SDLC or X.25-compatible protocol specifications.

NCR's DNA supports point-to-point or multipoint connections to most systems in NCR's product line. As with Univac's DCA, front-end processors are an optional accessory.

In 1979 NCR acquired Comten, a company that produces IBM-compatible communications equipment. Since then, NCR's software communications products have begun to migrate towards full IBM compatibility. The DNA philosophy has been altered and is now more generally referred to as the Communications Network Architecture (CNA). Even the packet protocol, Bold, has been revised to become NCR/DLC. Further enhancements can be expected from NCR; they will allow the vendor to place its terminal networks transparently within a complete SNA network.

DS (Hewlett-Packard)

Distributed System (DS) is Hewlett-Packard Co.'s distributed processing system, which was released in 1977.

As with DCA, DS allows the flexibility of adding an optional front-end communications processor to the communications nodes in order to remove much of the communications processing load from the host CPU. The hardware interfaces are all microcoded; this microcode software builds the transmission protocol units and forms the lowest level in the DS network architecture, the communications access method. This layer is accessed by the communications management layer, which provides all local system management routing and queuing functions.

There are two high-level layers, the network services intrinsics and the network interface monitors, which generate messages to be acted upon and process received messages, respectively. This effectively creates a master/slave relationship between any message-generating and receiving node.

A DS system can be generated to allow for any subset of the following capabilities: resource sharing, task-to-task communications, remote command and job submission or network utility use. Point-to-point or multipoint asynchronous or synchronous line connections are supported by DS.

There are separate DS systems for the HP 1000 and HP 3000 computer series, with only limited interconnections being supported between the systems (a DS/3000 node can only connect into a DS/1000 system as an end node). The distributed routing decisions are based upon a fixed intended routing table, making regeneration of the network topology a rather tedious task. Originally, the DS system only supported a special-purpose HP transmission protocol; however, additional microcoded interface boards are now available to allow the system to support HDLC as well.

DSA (Honeywell)

Honeywell Inc.'s Distributed Systems Architecture (DSA) is essentially an enhanced version of its earlier Distributed Systems Environment (circa 1977).

DSA consists of seven logical layers: the application layer, which gives the end user an interface to the system and provides several utility functions; format control, which provides any required message mapping; session control, which provides session management; transport control, which does message routing, multiplexing and control; network path control, which breaks messages into packets and routes them through the system; link access control, which transmits the packets using either HDLC or any IBM or Honeywell communications protocols; and a physical hardware control interface layer.

Most V

"Networks of the future will eventually encompass all forms of data processing, word processing, fax and digital voice transmissions."

The basic architecture of DSA closely resembles that of the Open System model. It was designed for use with Honeywell's Level 6 minicomputers and the optional front-end processors so that they may connect to the X.25-compatible PDNs. Recently, this architecture was implemented on the Datanet Eight front-end processor using the Distributed Network Supervisor package. This product (a Level 6 unit that operates as a front-end processor for the larger host systems) allows DSA concepts to be extended to include the full line of Honeywell computers. Hierarchical-type structures may be built using a special DSA software product and Level 6 remote computers, the Distributed Satellite System. Honeywell has stated that it is presently developing a DSA-to-SNA interconnection network link.

Primenet (Prime)

Primenet is the software program introduced by Prime Computer, Inc. to allow that company to compete in the area of distributed data processing. It consists of Level I through Level IV.

The first level specifies the electrical interface to be used in the communications process. This layer makes use of either Prime's Multiple Data Link Controller or Prime's Primenet Node Controller.

Level II manages the link by building HDLC (LAP), bisync or Prime hardware-implemented PNC character protocol units (developed for use in local network connections).

Level III manages the communication line, creating packets, managing flow control and providing all required message service routines in order to carry out all the necessary network transmissions.

Finally, Level IV provides the user interface for performing all the supplied network utility functions.

Users may directly access either layer three or layer four, depending on the operations they wish to carry out. Primenet supports task-to-task communications, transparent remote file access and network virtual terminal over Prime's entire product line. Communications can take place through direct or multidrop lines using X.25-type protocol standards.

Xodiac (Data General)

The Xodiac system, introduced by Data General Corp. in late 1979, was one of the first systems specifically built with X.25 specifications.

Xodiac is composed of four levels: the physical link layer, the link control layer, the connection layer and the functional layer. The first thre layers directly correspond to X.25's three layers. The fourth layer, the functional layer, provides user-transparent access to the network directly through the operating system.

Layer four consists of a resource management agent to provide full remote peripheral access and a virtual terminal agent to give access to remote operating systems, programs and utilities. These facilities allow Eclipse series users to control remote processes, transfer files between machines, perform task-to-task communications, gain access to remotely located devices, logically connect to remote systems and collect statistics on and isolate communications fault occurrences. It has a major limitation in that at present, users are limited to point-to-point connections (possibly through a PDN).

A Distributed Future

The vendors, for the most part, seem to be aiming the development of new systems and enhancements to existing ones towards the recommendations made by the Open System Interconnection model.

The user community is somewhat reluctant to completely embrace many existing networking concepts. Largely this can be attributed to the degree of sophistication these networks tend to take on (and the care required of their design) and the users' general fear of locking themselves into one vendor's architectural product line.

As hardware prices decline further, as work continues on the Open System Architecture and as the architectural standards are accepted by the industry, large, diverse networks will develop around complete, consistent information concepts rather than the relatively small, limited networks which form today's distributed network norm. These data communications networks will eventually effectively encompass all forms of data transmissions including data processing, word processing, facsimile and digital voice transmissions.

One can envision an exciting new world opening up as these advanced information concepts are incorporated into a consistent network architecture. In moving forward towards such a future, one can only acknowledge that the possibilities distributed processing can offer are almost unbounded. ◆

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VIDEOTEX:

What hath God wrought!

— *Samuel Morse*

After a day of sitting in front of a CRT terminal at work, Sir Toby Belch, a hypothetical British executive, arrives home at his London apartment. Forgetting to remove his coat, Belch mixes himself a gin and tonic and turns on his color television set. Coat on and drink in hand, Belch steps back from the set and slinks into his Soft Wear chair. He erases thoughts of work from his head by rubbing the drink across his forehead.

Bored with "The Adventures of Paddington Bear" on the BBC, Belch presses "130" on a hand-held keypad attached to his television set. The program disappears. The index for today's *Financial Times* appears in four colors. "Whoever thought the BBC would deliver *The Financial Times* in color," he chuckles.

Belch remembers that he doesn't have money in his checking account for the rent. He presses another button on the keypad, and the index for the London Information Center (LIC) appears. This service connects Belch's television set to stores, banks and the public library via the LIC computer.

Belch types his password on the keypad. A few seconds later, an index for his bank appears. Belch presses "2" on the keypad for "Savings to Checking." The set displays the directions for the transaction.

Sipping his drink, Belch wonders whether to access the Beef Wellington recipe on the BBC. Meanwhile, a printer in the next room taps out a record of his bank transaction.

Familiar Scene

This scenario may sound like another chapter in the "home of the future" saga. But similar scenarios take place today in thousands of British homes and businesses because of a concept called videotex.

Videotex has two distinct forms of in formation transmission — teletext and viewdata. Teletext, developed by the British Broadcasting Co. (BBC), refers to the transmission of textual data and graphics to an adapted television set via broadcast signals. Viewdata, a service of the British Post Office (BPO), refers to the interconnection of an adapted television set to a computer via the telephone lines.

Although teletext and viewdata belong to the genre of videotex,they have managed to live separate lives.

In the early '70s both the noncommercial BBC and the commercial Independent Broadcasting Authority (IBA) added teletext services to their regular programming. The BBC calls its service Ceefax; the IBA, Oracle.

In the late '70s, the BPO announced a viewdata service with the trade name Prestel. The Prestel service allowed subscribers to gain access to large amounts of textual and graphics information stored in a computer data base.

Prestel Tale

The Prestel Business Directory clearly states, "It is no accident that viewdata was invented in Europe rather than America. The telecommunications monopoly enjoyed by the British and the other European [postal, telephone and telegraph PTT authorities] makes it much easier to conceive of a single nationwide service connected by telephone lines into people's homes: an up-to-date version of the Victorian handbook 'Enquire Within Upon Everything.' "

The credit for the viewdata concept and Prestel belongs to Sam Fedida, a former BPO research engineer. Fedida conceived the idea during the late '60s when he was working on a computer register of hotel vacancies. He realized that systems costs would be reduced if the customer were able to gain access to the information without the need for clerks as intermediaries. When he joined the BPO to work on the Viewphone (similar to AT&T's picture

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Elizabeth M. Ferrarini is editor of "Viewtext," a newsletter on interactive telecommunications published by Information Gatekeepers, Inc., Brookline, Mass.

VIDEOTEX IN THE U.S.:

By Phil Hirsch

CW Washington Bureau

PORTLAND, Ore. — A novel videotex system that uses a shared decoder to spread terminal costs among a number of users is likely to begin operation here within the next year.

The new system was designed by Canadian Cablesystems, Ltd. (CCL), Canada's largest cable TV operator, and will be installed and operated by a U.S. subsidiary of CCL, Cablesystems Pacific. The latter company was recently selected by Portland's city fathers at the end of a competitive bidding derby.

Barring an adverse public referendum, the franchise will be officially awarded to Cablesystems Pacific shortly, according to Roger Keay, CCL's special projects coordinator. A similar system is to be installed in the southwest suburbs of Minneapolis and is being considered by the cities of St. Paul, Minn., and Santa Ana, Calif., Keay added.

In a typical videotex system, the user selects information by keying specified codes into a keypad or keyboard. This information passes through a modem and is transmitted to a central, computerized data base. The TV display is then sent back, goes through a display generator and is output on the user's TV screen.

Both the modem and the generator are housed in a decoder, a black box attached to the TV set.

Decoder Cost

One big obstacle faced by videotex promoters is the high cost of the decoder. It is often the most expensive component of the terminal installation, ranging upward from $200. In the case of Telidon, the Canadian-developed display-formatting scheme to be used in Portland, decoders cost well over $500. Essentially this is because Telidon requires additional decoder logic and memory to produce a higher quality display than in other formatting schemes.

CCL has solved the cost problem by sharing the display generator among a number of users.

Portland's new cable TV system will consist basically of a two-cable residential network and a single-cable institutional system. The residential cables terminate at three hubs; four trunks will fan out from each hub to as many as 60,000 subscribers. The display generators are installed at each hub. As a result, each display generator will be shared by about 250 users.

Subscribers will pay $10.45 per month for the Expanded Service to be offered by the new system. This includes Telidon interactive offerings plus a variety of broadcast services. Those services range from commercial TV programs, originated by local and distant stations, to specialized services, such as coverage of local city council meetings with on-line polling of viewers.

According to Allan Lodberg, CCL's project manager, "Expanded Service would cost at least twice as much if we didn't use remote display generators."

Lodberg admits that sharing will impose some constraints on the Telidon services that can be provided. The amount of information included in each TV frame, for example, must be limited to prevent an individual user

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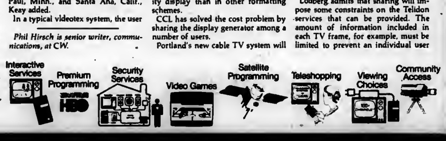
Phil Hirsch is senior writer, communications, at CW.



By Elizabeth Ferrarini

THE RACE TO PLUG IN

phone), Fedida had an opportunity to expand his ideas. From experiments with putting text onto Viewphones in hopes of increasing telephone usage to boost revenues, he moved to the idea of adapting the ordinary television set as a receiver of textual information.

By July 1974, a working model of viewdata was demonstrated to Sir Edward Fennessey, then deputy chairman of the post office and managing director of telecommunications. Fennessey immediately had the marketing division of the BPO explore the idea of viewdata.

In 1976, the BPO ran a test of its viewdata service in London. Two years later, the BPO embarked on a test service of Prestel in London with 1,500 free subscribers.

IP Philosophy

Because the BPO was providing a new means of communicating information, it did not want to become a publisher. The BPO decided to become a common carrier by providing the lines, switching and computer power and storage within the network. The data would come from outsiders or "information providers" who would sell their data to a mass market. The

The BPO would allow any organization to store as many pages as it wished, but would not allow any "grossly offensive or unsuitable information." Using this approach, the BPO developed the test service in close cooperation with 150 information providers. Some of them included American Express, *The Financial Times* and British Airways.

In turn, the information providers had the responsibility of formatting their data according to the BPO's rules, updating it, advertising it and paying the BPO to store it. The information provider would be paid on an access basis.

The BPO stored the information in a network of identical GEC 4080 computers from General Electric Computer Ltd. (no relation to General Electric Co.), which would update the changes. Equipped with several computers, selected telephone exchanges in London acted as Prestel computer centers; a local call connected the subscriber to the nearest computer center.

Encouraged by the success of its test service, the BPO announced Prestel as a public service on March 27, 1979.

THE PORTLAND PROJECT

from tying up the character generator and forcing others who are sharing the equipment to form long access queues. However, such constraints are likely to be temporary.

"We're looking at a number of possible enhancements which might be implemented within a year or two after the Portland systems goes on the air," Keay said.

One of these enhancements involves the use of a packetized formatting scheme to transmit access codes and related information from the Telidon user's terminal to the cable network's control center and data base. Each user could be equipped with his own display generator as well as a full-Ascii keyboard.

In the initial system, the user will have a numeric-only keypad, which will severly limit the amount of information he can input. The keypad won't accommodate credit card numbers, for example, thus reducing the system's ability to support teleshopping services. The keyboard, besides expanding the range and depth of teleshopping, banking and similar services, might also accommodate a store-and-forward electronic mail/message offering.

Portland has already decided to lease 10 TV channels on a shared or dedicated basis for teleshopping, according

"We also intended to install a video disk subsystem that allows photographs, as well as text and simple graphics, to be displayed on the viewer's screen," the special projects coordinator said. A future "possibility" is a home computer system, which may be tied to a national computing network.

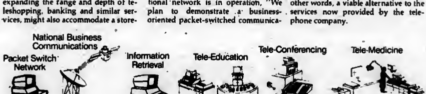
Initially, the institutional network will be limited to point-to-point data communications services, plus switched services if the user supplies the switch. The network will consist essentially of 25 forward and 17 reverse channels. Each will have a bandwidth of 6 Mhz and be able to accommodate transmission speeds up to 6M bit/sec. A channel will be subdividable into all of the popular data rates.

During the second year the institutional network is in operation, "We plan to demonstrate a business-oriented packet-switched communication service" Keay reported. "The following year, we expect to offer such a service commercially."

Interconnection with intercity communication networks is also planned, although the details have not yet been worked out, Keay said. One possibility is that the Portland system will interface with GTE Telenet Communications Corp.'s packet-switched network and/or satellite carrier such as Satellite Business Systems (SBS) or American Satellite Corp.

SBS shortly will begin demonstrating data communications service consisting of a transcontinental broadband satellite channel connected to the Manhattan Cable Co. network in New York City and to cable/microwave local distribution facilities in San Francisco.

A major goal of Portland's projected institutional service appears to be deployment of a high-speed, highly reliable local-area network, tailored specifically to the data communication user's needs at an attractive price — in other words, a viable alternative to the services now provided by the telephone company.



"Eleven Prestel computer retrieval centers have identical copies of the data base. One center in London functions as an update center."

Today, 11 Prestel computer retrieval centers exist throughout the UK using GEC 4082 computers instead of 4080s. Each retrieval center has an identical copy of the data base, and one center in London functions as an update center. An information provider can update its page on-line from an editing terminal or via magnetic tape transfer.

Each GEC 4082 computer in a retrieval center can handle 200 calls simultaneously. The computers are connected to the telephone lines via 4,800 bit/sec links.

A television set adapted to receive Prestel requires a box of additional electronic circuitry called a decoder. The decoder may be built into the set or into a black box that plugs into a conventional set. Controlled by one or more microprocessors, the decoder's large-scale integrated (LSI) circuitry features an auto-dialer, an identification number, a character generator, a page store, an interface board and a modem. A remote-control or plug-in, numeric-only keypad comes along with the decoder.

The auto-dialer remembers the telephone numbers of the computers it is likely to access and dials them at the press of a button. An identification number lets the Prestel computer know which terminal to bill for page access. The interface board allows the set to be connected to the telephone lines. The Prestel computer transmits data to the television set asynchronously at the speed of 1,200 bit/sec and receives data back from the set at 75 bit/sec. Transmission occurs independently of the TV signal.

As data from the Prestel computer arrives at the television set in the form of audible tones, the modem changes these tones back into digital computer codes. The 5 by 7 dot-matrix characters that correspond to the digital codes are fetched from the character generator's read-only memory. (ROM) and passed to the page store's random-access memory (RAM) for display on the screen.

Seven Colors

One hundred and twenty-eight different Ascii-coded upper- and lowercase characters, numerics and symbols can be generated in seven colors on the set. The colors are white, yellow, cyan, magenta, red, green and blue. Graphics are built up as an alphamosaic of rectangles by a sequence of 64 character codes on a 2 by 3 dot matrix. A set of control characters determines alphanumeric or graphics modes, color background and double-height characters.

The subscriber uses a numeric keypad to access the desired page of information, to hold a page for viewing or to cancel the keying instruction.

A page or frame of information in the Prestel data base is the amount of text or graphics that can be displayed on the television set CRT screen at one time. The European 625-line television standard easily accommodates the format of 24 rows by 40 characters — a total of 960 characters. Each row uses about 20 television lines. The BBC and the IBA set this format as the standard for teletext. Use of the same display format for teletext and viewdata means that the similar LSI components in a television set, except for the modem and some of the decoding functions of the circuitry, can be used to receive both services. A set modified for viewdata can receive teletext, but a teletext-only set cannot receive Prestel.

To obtain Prestel information with an adapted television set, the subscriber turns on the set, plugs in the keypad, makes sure the telephone is not in use, and then switches

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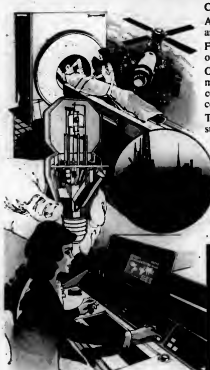

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"A Prestel subscriber has access to 163,000 pages of information from airline schedules to games, quizzes and advertisements."

to Prestel according to the operating instructions supplied with the set. During this process, the autodialer makes a local telephone call to a Prestel computer center. The Prestel computer scans the identification number built into the subscriber's set.

Once the "Welcome to Prestel" display appears on the screen, the subscriber can access the tree-structured text in several ways. By pressing "#" on the keypad, the subscriber calls up the General Index. This index contains a variety of selections, each preceded by a number. The subscriber keys the single digit that corresponds to the subject of interest. For example, the subscriber would key "5" to view the Alphabetical Index. This prompts a new index to appear that is specific to that subject. Further single-key selections narrow the choice; for example, from "Government Information" to "Parliament" to "Legislation" until the desired page is located. This method supposedly allows the most simple-minded human being to access data.

Because each page in the Prestel data base is assigned a number, the subscriber can access the desired page by the number assigned to it in the Prestel User Guide and Directory. By pressing one of the special keys on the keypad, the subscriber can return directly to the main index or to the previous page, or it can repeat an existing page. One of the keys is used to access information on subjects that request more space than a single frame can accommodate. The extra pages are labeled a,b,c and so forth.

What Prestel Knows

A Prestel subscriber has access to about 163,000 pages of information ranging from airplane timetables, theater guides and encyclopedia information to games, quizzes and advertisements. About 254 information providers now supply this information.

Although Prestel has something for everyone, the business community can take advantage of a large number of business information services operating through Prestel. Established in December 1978 by the Financial Times and Exchange Telegraph, Fintel — the largest of the Prestel information providers — offers daily news with analysis and comments on industry and finance.

Datastream International, a financial company, provides stock market information, economic forecasts and a major data bank of company account displays. The London Stock Exchange each day lists on Prestel the prices of 800 leading stocks.

Although Prestel was designed as a public information service, the BPO allows information providers to restrict access to designated users or what is called a closed group of users (CUG). For example, an information provider such as a manufacturer may elect to put its company parts list on Prestel. The company would allow its salespeople to access the data by assigning them a special Prestel access code.

While connected to the Prestel computer, the subscriber incurs three separate costs. First, the subscriber pays for the local telephone call and the time logged on to the computer. The latter is set at 7 cents per minute during peak hours. The rates are lower during off-peak hours.

The user also pays a charge levied on each frame by the information provider. This charge may be from zero for advertising and public affairs pages up to 20 to 24 cents for business and industrial information. However, information aimed at the general public is priced between 1 cent and 6 cents per page.

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"Business will pay almost anything for data. This is why Prestel had 4,678 business customers and only 610 residential subscribers as of late 1980."

Prestel comes to about 20 cents per minute or $12 per hour, according to a participant at the Viewdata '80 conference.

The BPO requires that each information provider display the price on each page in the upper right corner. The Prestel computer gives each subscriber a running total of the amount of each call and the total billing for the current quarter. The charges levied by the information provider are collected by the BPO, which passes the money to the information provider after deducting a surcharge.

The information provider pays the BPO a yearly service charge of $10,000 and about $10 for each page stored by the service. With a five-year service contract, an information provider pays $6,000 per year and $5.50 to store each page.

Besides the cost of information, a subscriber must bear a third cost: that of obtaining the adapted set or circuitry needed to receive Prestel.

The circuitry needed to modify a color television set to receive Prestel costs as much as $1,000. A new, full-featured 26-in. color television set equipped to receive Prestel and teletext costs about $2,150, according to the Videotex Research Unit of Butler Cox & Partners Ltd. Without Prestel and teletext, the same set costs $1,057.

But 67% of the people who have sets in the UK prefer to rent them. A television set that receives both Prestel and teletext rents for $42 to $58 per month. A teletext-only set rents for $35 per month. Without these services, a television set rents for considerably less.

TV Set Costs

The high cost of television sets which receive Prestel is due to the specialized semiconductors and subassemblies (such as modems) that have been in production for only a short time. These components require a few years of evolution before low production costs can be achieved. Even when the units to adapt a set reach a price range that the mass market can afford, there is no guarantee that consumers are going to want to pay for the information.

Meanwhile, the business community considers the price of the information and the necessary equipment as minor. Businesses will pay almost anything to get the appropriate data, expecially if the data is easy to obtain. This rationale explains why Prestel had 4,678 business customers and only 610 residential ones at the end of August 1980. But to keep the business community interested in Prestel, the BPO will need to offer more business services. Thus far the most popular pages on the service are games and quizzes offered by Baric, especially the Desert Rat game.

Prestel subscribers can respond to the computer by use of the "response page," specifically an advertiser's response page to send for more information. Because the response page automatically identifies the terminal being used, the advertiser knows where to send the information. The subscriber's request stays in the Prestel computer until the information provider collects its responses.

The response page makes shopping via Prestel — teleshopping — possible. For example, a page in the American Express data base lists all of the information providers that accept American Express cards for teleshopping. This list includes a retail store called Debhehams, which sells small items such as calculators and squash rackets. To order goods from Debhehams, the subscriber would access the store's response page.

Because most subscribers do not have alpha keyboards, the

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"Despite its flaws, Prestel does have one redeeming characteristic: It works."

teleshopping information providers have set up the response frames in a fixed format. This format identifies products by a number. The subscriber keys in the product, the quantity and his American Express card number. Goods can be picked up or delivered to the address of the terminal.

A more recent development in Prestel, especially for businesses, is the intelligent viewdata terminal. This device has independent computing power, memory, a storage device and a printer. An intelligent viewdata terminal would allow a user to store viewdata frames of information, such as stock market prices. Using this information, an investment manager, for example, could then use the terminal's computing power to undertake his own portfolio analysis.

The Redifin Computer, Ltd.'s Viewdata Plus functions as a television that receives Prestel and teletext and as a conventional data processing terminal. Standard Telephone and Cables Ltd. offers a desktop Prestel receiver for the business community.

Telesoftware developments will be of interest to the owner of an intelligent viewdata terminal. The British software group, CAP-CPP, has already demonstrated software that allows a computer program stored on Prestel to be transferred to an intelligent terminal. The software in the user's terminal allows it to translate each one of the Prestel software frames to machine-readable code. But it takes time to load a program from Prestel into a terminal. For example, if the program contains 30 pages of information and five pages per minute can be loaded, it would take six minutes to load the entire program.

Because the BPO does not have a monopoly on viewdata systems, a business may develop its own system. To access Prestel, a user with a private viewdata system would need a Prestel-compatible terminal, such as the Redifin Plus.

The BPO has made no provision for tying external computers into Prestel.

GEC Computers Ltd., Radifin Computers Ltd., ICL Computers Ltd. and Incoterm Ltd. have developed proprietary private viewdata systems. Whitbread Ltd., a brewery, uses its GEC system to communicate between its home office and subsidiaries. At present, the number of private viewdata systems remains small.

The resolution on a modified television set has not reached the point where someone could sit in front of a set and read Shakespeare via Prestel.

Some companies, such as mail-order houses, find it difficult to advertise some of their products via Prestel graphics. The crude alphamosaic technique of displaying graphics lends itself to easily recognizable products, such as books. *Playboy* centerfolds will have to wait until the graphics are improved.

Meanwhile, the BPO engineers have developed and demonstrated Picture Prestel, a photographic technique of displaying graphics within a page. However, centerfolds may still have to wait. The BPO plans to introduce Picture Prestel in 1987. Because this graphics technique involves another generation of decoders, the BPO may not want to scare the television set makers by announcing Picture Prestel too early, according to some observers.

Despite its flaws, Prestel does have one redeeming characteristic: It works.

Marketing Prestel

The Prestel service has taken its lumps on a foundation laid down by British taxpayers.

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"The British Post Office prided itself on being the first with the idea and decided to offer Prestel to the rest of the world."

About $65 million was budgeted for testing and early public service, but the BPO does not have to return a profit on that investment. Instead, the BPO claims that the cost of information and price of television sets and decoders to receive Prestel will plummet soon. The BPO hopes the service will be self-sufficient in a few years. Nonetheless, the BPO prided itself on being the first with the idea and decided to offer Prestel to the rest of the world. By doing so, the BPO could have Prestel accepted as the viewdata standard, especially in Europe, and could take advantage of the economies of scale essential in producing television sets using LSI technology.

The BPO's first attempt at marketing Prestel was to other European countries' post offices — PTTs. In 1979, the Deutsche Bundespost (West Germany Post Office) took delivery of a GEC 4082 computer from GEC Computers Ltd. and licensed a complete line of software from the BPO. The market trial for the German viewdata service, called Bilschirmtext, allows information providers to hold their information in their own computers. The information provider, in turn, rents an interface from the PTT. The interface allows the subscriber to dial into Bilschirmtext and to be switched automatically to the information provider's computer.

For its test service, called Viditel, the Netherlands PTT uses the BPO's Prestel software and GEC 4082 computers. When the test service began on Aug. 7, 1980, 2,000 terminals were placed in Dutch homes.

To continue exporting the British expertise in developing viewdata software, the BPO gave Insac Data Systems Ltd. a license to market Prestel and related know-how in Europe. In February 1979, the BPO signed an agreement with Insac which licensed its American subsidiary — Insac Viewdata, Inc. — to exploit Prestel and related technology in the U.S. and Canada for three years.

The British National Enterprise Board (NEB), a government venture capital organization, originally spawned Insac to export British software expertise.

In June 1979, General Telephone and Electronics Corp. (GTE) entered into a two-year exclusive agreement with Insac Viewdata, Inc. for Insac Viewdata's Prestel-like software designed for U.S. communications standards. Under this agreement, GTE obtained a sublicense to Prestel. Two months later, GT Directory Co. (a GTE subsidiary) was awarded a $776 million contract to print the British Yellow Pages for the next 10 years.

The exclusive agreement between GTE and Insac called for GTE to install computers with viewdata for both GTE's and Insac's use. GTE would explore the public-service market and Insac, the corporate market. In the meantime, Insac concentrated its marketing efforts on signing contracts with major U.S. corporations for a trial.

In February 1980, Insac, the helpless child of the NEB, became the helper by changing its name to Aregon (the Greek word for "helper"). Supposedly, the name change resulted after the NEB decided to separate some of the company's activities.

The newly named company did not sign up any major U.S. corporations for a viewdata trial. Instead, Aregon Viewdata, Inc. convinced 20 major corporations to rent terminals that would access the viewdata software. The 45 rented terminals were connected via GTE's Telenet service to a computer located at the GTE Data Center in Tampa, Fla.

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"In the U.S., Aregon Viewdata and British Telecom will sell software independently. But both will try to establish UK products widely."

The GTE Data Center also served as the site for GTE's experimentation with the software licensed from Aregon.

The companies involved in the Aregon venture included ABC, CBS, McGraw-Hill, Inc., J. Walter Thompson Co. and a few others. "All types of data imaginable were stored," said John Bately, president of Aregon. "The companies did not have any trouble formatting it."

The J. Walter Thompson Co., the largest independent advertising agency in the world, used its terminal to test how its clients' products would appear on this type of media.

When asked how viewdata compares with other information retrieval software, Bately said that "viewdata is economical and simple to use." A company can use the software to set up its own in-house viewdata system, which allows employees to access timely information, according to Bately.

In August 1980, GTE decided to make its agreement with Aregon nonexclusive. "Aregon will explore both home and business markets with all sorts of other people," Bately said. Sources within GTE say that GTE never really conducted a trial with the software.

The Aregon trial (as Bately called it) was a positive experience. "We have learned a lot about what corporations do," he said. "Companies want security and want to access a mainframe. We have done a lot of software modifications and are offering it as a turnkey system or just the software."

Supposedly all the terminals were returned to Aregon and no sales were made.

In October 1980, after an 18-month attempt at marketing the BPO's Prestel software in the U.S., British Telecom, the telecommunications arm of the BPO, decided to give Aregon some help.

Under the three-year contract with British Telecom, Aregon Group Ltd. will coordinate information on a range of associated equipment and services for Prestel that are provided by other UK companies. In addition, Aregon will help British Telecom draw up proposals for PTT administrators in other nations and will be the recommended supplier when custom-made features are needed. In the U.S., Aregon Viewdata and British Telecom will sell the software independently. But both organizations will try to establish UK-developed products as widely as possible.

Meanwhile, GTE has unofficially proposed a viewdata service called Infovision. Using a home terminal, an Infovision subscriber would access information supplied by participating newspapers. The newspapers would link their data bases to the consumer's terminal via GTE's Telenet service. Besides offering local news reports, the newspapers would sell classified ads on the service. Another part of the service would be a GTE-supplied electronic telephone directory service.

Unless GTE can get a half-dozen newspapers to participate at about $1 million each, this service may not transcend GTE's vision. Meanwhile, the company has reported that British technology probably would not be used. Established in December 1979, GTE Communications Systems, which includes Telenet, oversees the company's viewdata activities.

An international marketing trial of the British Prestel service got under way in March 1980. The seven countries participating in the one-year trial service are Australia, West Germany, the Netherlands, Sweden, Switzerland, the UK and the U.S.

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"In July, Prestel International will become a full public service sponsored by Logica Ltd. in the UK and Logica, Inc. in the U.S."

11,000-page Prestel data base. Information providers for this data base include the following British sources now on Prestel: Baric, Economist and Fintel. U.S. information providers include *Newsweek*, the Official Airline Guide, *The Wall St. Journal* and Dow Jones & Co. Data is transmitted to specially designed television sets via RCA's low-speed packet satellite service.

To date, over 300 terminals have been committed. U.S. participants in the test include IBM, Chase Manhattan Bank, Paat Marwick Mitchell & Co. and Manufacturers Hanover Trust.

Logica Ltd., a British software house, was selected by the BPO to carry out the test. The company did the feasibility study for the project in 1978. In July, Prestel International will become a full public service sponsored by Logica Ltd. in the UK and Logica, Inc. in the U.S.

Ceefax and Oracle

Individual video frames shown at the rate of 30 frames per second compose a television picture in a U.S. TV set. A European-made set shows 25 frames per second. Because these frames are shown so quickly, the human eye sees a continuous motion.

An electronic beam scans each frame's broadcast signal onto the screen in the form of two interlaced patterns of individual horizontal lines. In a U.S.-made television set, the beam scans each 525-line frame in two consecutive fields of 262.5 lines each. In a European-made set, the beam scans each 625-line frame in two consecutive fields of 312.5 lines. Both American and European-made sets use the same scanning process.

Starting from left to right at the top of the screen, the electron beam scans the first field of lines onto the screen. When the beam reaches the bottom of the screen, the beam must shift to the top of the screen. This shifting allows the beam to scan the next field of the frame or to scan the first field of a new frame.

The shifting of the beam is called the vertical blanking interval. During the vertical blanking interval, the lines in the broadcast signal that do not contain picture information allow time for the beam to reshift. Both American and European-made television sets have 21 unused lines available to the beam during each field's vertical blanking interval.

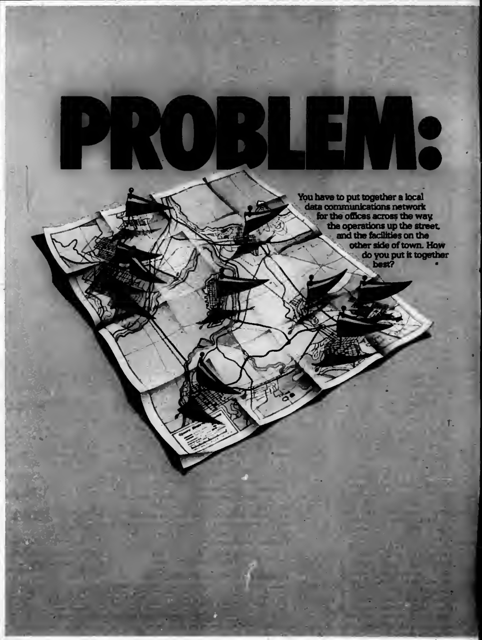
In the Beginning

In the late '60s, engineers from the BBC Designs Department tested the transmission of textual data using lines in the vertical blanking interval of the television signal. They called this method Teledata.

In 1970, the BBC engineers also tested other methods of transmitting data, but they found Teledata to be the best method. Two years later, the BBC filed a patent application entitled "Transmission of Alphanumeric Data by Television." In May 1972, the BBC published a proposal that described the use of Taledata as a public service.

In July and August of that year, the BBC engineers went to work on building prototype equipment for a trial Taledata service. In September, the Teledata proposal was renamed Ceefax (a Madison Avenue version of "see facts"). The requirements for the future Ceefax service included the following:

- The capacity of the service should be large enough to allow the broadcaster to provide a comprehensive range of information.
- The transmission of data should be accomplished without interfering with normal television viewing.
- The cost of the adapted television receiving equipment


PROBLEM:
You have to put together a local data communications network for the offices across the way, the operations up the street, and the facilities on the other side of town. How do you put it together best?

"With Ceefax and Oracle, each broadcaster assembles pages from a data base and sends them via the airwaves to teletext-adapted sets."

should be reasonable.

A test of Ceefax took place from July 1973 to April 1974. During the same time period that the BBC was working on its Ceefax service, the Independent Broadcasting Authority had been working on a similar development. In March 1974 the BBC, IBA and British TV manufacturers defined an initial standard for this new medium which was given the generic name teletext.

In September 1974 the BBC began a two-year experiment of Ceefax, and the IBA began similar tests of its teletext service called Optional Reception of Announcements by Coded Line Electronics (Oracle). Both the BBC and the IBA in 1976 received full government support to begin nationwide public teletext services. Also, the government approved teletext as part of the BBC's permanent charter. Sales and rentals of teletext-adapted sets hit 40,000 by the end of 1979. More than 95,000 sets in the UK were receiving teletext at the end of 1980.

No Information Providers

A report published by the Committee on the Future of Broadcasting in 1977 recommended that the BBC and IBA be authorized to provide full teletext sevices, as opposed to being a carrier of information like the BPO. The report specifically stated that "newspapers should not be given the right to participate with the broadcasting organization in the development of these services." This declaration meant that the BBC and the IBA had the task of gathering the information and disseminating it to the public. Meanwhile, the government expected newspapers and publishing groups to play an integral part in the BPO's Prestel service.

For the Ceefax service, the BBC employs a staff of 20 journalists. Three journalists work on the financial section, and two journalists specialize in labor. The remaining journalists have to be adept at writing anything from general news to gardening notes or putting details on a weather map.

Most of the sports and financial news originates from a variety of wire services. General News Service, the internal BBC service, provides most of the information. Other wire services include Reuters and the Press Association.

Unlike the BPO, the BBC and the IBA have no information providers to rely on for funds. Instead, the IBA depends on commercial advertising to finance Oracle. The BBC receives funds for its teletext service from the compulsory Broadcast Receiving License fee, which every television owner must pay yearly. At the end of 1979, the fee was $54 for color televisions, $27 for black and white.

Nuts and Bolts

With the Prestel service, the subscriber has the luxury of being on-line with a tremendous data bank of information. With the Ceefax and Oracle teletext services, each broadcaster assembles specially selected pages from a data base and transmits the pages via the airwaves to viewers who have teletext-adapted sets.

Each collection of pages that a broadcaster assembles is called a magazine. At present, each magazine contains 100 pages that feature news, weather and sports.

Once the magazine has been assembled, each 40-character row of information on the page is digitized. The transmission of pages occurs in a fixed format: Two designated lines in each field's vertical blanking interval carry one row of digitized data. Each row of information in a page gets transmitted one after another until the page has been

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"Unlike the Prestel subscriber who has immediate access to data, a teletext viewer must wait from 10 to 12 seconds for each page."

completed. Transmission of the next page begins. Repetition of this process occurs for all the pages in the magazine. The broadcast cycle ends when all pages in the magazine have been transmitted. Another broadcast cycle of the same magazine — which may contain updates and new pages — begins immediately.

Transmission of the data occurs at the rate of 100 rows of digitized data per second — an instantaneous bit rate of 6.9M bit/sec. The fixed format for transmission allows the position of data in the vertical blanking interval to have a direct relationship with the position of data on the television screen.

Each 100-page magazine takes 24 seconds to broadcast, about four pages per second.

The transmission of data in unused lines during the vertical blanking interval does not interfere with the picture. While the picture is on the screen, the teletext data remains hidden until it is accessed by the viewer. On a poorly adjusted set the vertical blanking interval appears as a black horizontal bar.

How Teletext Works

To access data from either teletext service, the viewer turns to the appropriate channel that receives the service. By pressing "100" or "200" on a hand-held numeric keypad, the viewer calls up the General Index for the magazine. This index lists the subjects contained in the magazine and their corresponding three-digit page numbers. The viewer can type in the number for a particular page and receive either the page or a submenu for the category requested. Because the pages in each magazine can change with each broadcast cycle, the viewer accesses a complete index of the magazine's contents.

Unlike the Prestel subscriber and his immediate access to data, a teletext viewer must wait an average of 10 to 12 seconds for each page. If the viewer selects a page that has been transmitted, the viewer must wait at most 24 seconds for the page to come by in the next broadcast cycle because 24 seconds is the maximum time a 100-page magazine takes to complete such a cycle.

The viewer types in the desired page number and the teletext circuitry in the set holds it. When the page comes by, data extraction and recognition circuits examine the lines carrying data and extract those signals that make up the page that has been selected. the data from these lines is stored in random-access memory (RAM). The 5 by 7 dot matrix characters corresponding to the digital codes are fetched from the character generator's read-only memory (ROM) and passed to the page's RAM for display on the screen. Once the page appears on the screen, the viewer can hold it for as long as desired.

Services Provided

A viewer can access Ceefax or Oracle seven days a week from 7 a.m. to 11 p.m.

On BBC 1, the Ceefax pages provide daily news, weather, sports and other miscellaneous information. Because of the timely nature of the information, journalists update these pages at least once a day. Acting as a weekly magazine, BBC 2, the other channel for Ceefax, carries news, weather, sports, an entertainment section and special features.

Oracle provides the same type of information as Ceefax, but also carries advertising. Besides broadcasting pages of information, these two services can broadcast subtitles and superimpose text on a regular television picture. By requesting the Newsflash frame on the service, a viewer can watch a regular program and

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> **"Ceefax and Oracle could include a 220-character alphabet that would handle languages such as Cornish, Welsh and Wendish."**

have news or sports scores superimposed as a "box cut through the ordinary picture."

For the hearing-impaired, teletext allows subtitles (captions) to be broadcast and displayed with the picture. The viewer first accesses the subtitle page and then switches over to the regular program. The subtitles appear across the bottom lines of the screen during normal viewing.

Intelligence Behind Ceefax

Three Digital Equipment Corp. PDP-11/24s lie at the heart of the Ceefax service. One of these three computers handles the inputs from up to 16 CRT units. Each interchangeable disk stores 10,000 Ceefax pages. Five thousand pages are used to provide a library of pages that are likely to be used again. Wire services feed directly into this computer.

Journalists use Aston TCG3 keyboards that provide editing facilities independent of the main computer. These keyboards allow Ceefax journalists to make use of the teletext specification for formatting a page.

One video display unit is linked to a black-and-white television camera that allows ordinary pictures to be converted to Ceefax-style alphamosaic graphics. The journalists use a lightpen to amend the graphics.

The other two PDP-11/24s operate parallel output systems. Each output system provides a variety of options for assigning pages to television data lines; each system handles more than two data lines per television channel.

The output system also broadcasts subtitles. The subtitle inputs comes from a floppy disk that runs in sync witb a film or videotape. The subtitles can be written into the Ceefax magazine ahead of time.

Future Enhancements

Some of the future enhancements being proposed for Ceefax and Oracle include the development of a common core alphabet of 200 characters, the ability to link pages and transmission of photographs.

The 220-character alphabet would handle all of the variants of the Latin alphabet and also include languages such as Cornish, Manx and Wendish.

The ability to link pages would allow a viewer to program a selection in the decoder. When the viewer switches on his set, the chosen pages would be captured at the earliest opportunity. This capability requires a decoder with nonvolatible memory, another development being considered.

Telesoftware is also a future enhancement for Oracle. The Mullard application laboratory has designed and built the first experimental teletext telesoftware receiver. This receiver decodes and executes software programs broadcast as Oracle pages.

Access time for information may seem like a drawback to teletext, but British viewers have been willing to put up with an average 10- to 12-minute wait. One solution to reducing access time is to use more lines in the vertical blanking interval to carry data.

The ideal teletext service would make use of all the lines on a television set (full-channel). Because of other programming considerations, neither the BBC nor IBA may be in a position to offer full-channel teletext. Meanwhile, the BBC and IBA know about the problem and try to minimize it.

For example, pages of special interest, such as an index or special features, may be transmitted several times during the magazine's broadcast cycle. Special interest features may have self-changing pages; each page of the section stays on long enough for the viewer to read tt before the next page appears. It is possible, however, for a viewer to access Page 2 of a series of self-changing pages and then have to wait 24 seconds to read the first page.

The limited size of the magazine may seem like another drawback to teletext, but again the British viewers have been willing to put up with it. They keep buying or renting sets to receive teletext. Once a viewer rents or buys the set, the teletext information comes free. The average British consumer, like the average American consumer, cannot afford to be on-line for hours playing games with a computer via the telephone line.

Looking on the brighter side of Ceefax and Oracle, the television set manufacturers responded enthusiastically to the call for teletext decoders when the two services began. Texas Instruments, Inc., Mullard and General Instruments Corp. now produce decoders in ample supply. The price of a teletext-only decoder could add $300 to $400 to the cost of a conventional set.

But the more the viewers request sets, the lower the price will go. On the other hand, the BPO just couldn't get the television set makers to produce an adequate supply of decoders for the Prestel trial service.

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"Viewdata and teletext have different data rates and coding formats. By changing those, the two services could become compatible."

The incompatibility of Prestel and Ceefax/Oracla results from their living apart from aach other. Both the BBC/-IBA and BPO daveloped information services independently. Because telatext uses a one-way broadcast mode of transmission, viewers of Oracle and Ceefax pages cannot send a message back to a computer. On tha other hand, Prestel subscribers have the luxury of responding back to tha computer for ordering goods.

Although a viewer can obtain a television set that receives both Prestel and Ceefax/Oracle, the viewer must switch between the two services. Unfortunately, two wires in tha set cannot be put together to get desired compatibility between the television signal and the telephone line. Tha problem goes much deeper than that.

Viewdata and teletext hava different data rates and coding formats. Viewdata has 10 bits per word (a stop bit, start bit, parity bit and 7 information bits). By changing the data rate and transcoding the pages, tha two services could become compatibla — in a technical sense. For example, at a recent National Association of Broadcasters convantion in the U.S., talatext pages converted to viewdata pages were sent across tha Atlantic via telephone to the convantion floor. Tha participants at the convention were able to format the viewdata pages back into teletext pages.

From the applications standpoint, it should not mattar to tha viawer whare the data is coming from — broadcast or telephone lines.

If one envisions a hypothatical situation that uses both modes of transmission, the service would work as follows: A viawer telaphones tha computer to request that pages of software be downloaded to his intelligent terminal. The information service transmits the pages via the broadcast cycle (teletext) instead of the telephona line. Remembering tha request, the viewer's terminal grabs tha pages as they coma by in tha broadcast cycle.

This integrated type of service, referred to as inteltext, would optimize the use of tha telephone line. However, a fully integrated intaltext servica would allow the two methods of transmission to appear transparent to tha viawer.

French Connection

In the early 1970s, the French Centar for tha Study of Talephone and Telecommunications established a joint research center in Rennes to develop naw technologies for Talediffusion de France (TDF) — the country's only broadcasting company — and the Franch PTT. Like tha BBC's idea of Taledata, tha French came up with "digital acquisition and taledisplay of pictures arranged in tha form of a written page." In French the initials of aach word combined to form tha word Antiope (the nama of a Greek goddess).

Unlike the British, tha French decided to incorporate both telatext and viewdata capabilities in thair Antiope system. Thus Antiope emerged as a hybrid videotex system.

French President Valery Giscard d'Estaing in 1976 authorized Simon Nora, inspector general of tha Ministry of Finance, to write a report on tha impacts of computer technology on French society. While working with Alan Minc on the report, Nora coined tha word talematiqua to describe tha interconnection between computars and telecommunications. In thair report, Nora and Minc defined areas where telematiqua was likely to changa patterns of daily living and working — data processing natworks, information banks, taletaxt systems and facsimile systems. Tha report also outlined a national program to daal with these impending changes.

Simon Nora submitted the report "L'Informatisation da la Sociate" to d'Estaing in January 1978. This report, published in a book called *Computerization of Society*, has formed tha basis of Franca's grandiose national plan to integrate into ona system such things as teletext, viewdata and telephone directory assistance terminals.

Such a national videotex program meant that tha TDF and the French PTT would have to work together, not apart as do tha BBC/IBA and tha BPO. How this French connection devalops remains to be seen. Maanwhila, the TDF offars several teletext services, and the PTT plans to put trial viawdata sarvica into operation soon.

Tha TDF, in conjunction with the French Stock Exchange Committee, began a stock teletext service for traders and brokers in 1977. The service, which operates in Paris and Lyons, allows dealers to access more than 2,000 stocks daily.

Since 1979 tha TDF has also offered an experimental telatext weather-report servica. Moreover, last summer two French gasoline chains offared roadside teletext services. Terminals at tha gas stations offered weathar, traffic and road condition information.

Telematique Family

Tha French PTT has devised a viewdata family of equipment based on Antiope called Talematique. The equipment includes an Antiope-adapted viewdata terminal, an Antiope-adapted telephone directory assistanca terminal and two products undar davelopment: a facsimile unit and an alectronic writing tablet called a talewriter.

Tha French PTT has two sats of plans for Antiope and tha Talematique products: a nationwide viewdata service and an electronic directory service.

Teletel, the proposed viewdata service (and also the name of Antiope in tha viewdata moda), will begin servica this year in Velizy, a suburb of Paris. About 2,500 French homes will be equipped with Antiope-adapted color television sets connected to tha talephone lines via a modem. The TDF will use soma of thesa sets for testing transmission of telataxt.

Like the German Bundespost, the Franch PTT will provide only the telephona lines. Information providers can operate any infromation service they desire and will use their own computars to store tha data.

The service will use tha public switched telaphone natwork and the sama transmission speeds as Prestel. The Transpac packat-switched network will be used for long-distance telephone connections. Tha terminals will use a 25- row by 40-character page format and display graphics in the alphamosaic techniqua.

Mora than 150 information providars will participate in the trial servica. Besides tha type of information services provided by Prestel, Teletel will offer its subscribers a messaging service.

Futura products for the viewdata service includa the telewriter and tha facsimile unit. The telawriter allows input from a pressure-sensitive graphics tablet to be transmitted via tha telephone lines to a viewdata terminal. The facsimile unit will function as a hardcopy printer for the viewdata terminal.

Tha high point of tha French PTT's plans is tha distribution of an electronic telephona directory assistance terminal to every French telephona

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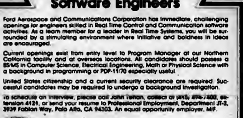
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"The French plan to invest a whopping $27 billion over the next five years to become the 'Charlemagne of the wired nations.' "

user. Rather than looking up telephone numbers in a paper directory or calling the directory assistance operator, the French will use a video display terminal with a typewriter keyboard to access telephone numbers.

The PTT's proposed combined-equipment program calls for the directory terminals to be used to access the national Teletel service. But the French haven't committed to this feature. Meanwhile, the initial directory-assistance terminals will be black-and-white CRT displays with an alphanumeric keyboard and a modem. The PTT ordered 1,000 terminals from each of four French firms: Matra, Thompson-CSF, Telic-Alcatel and TRT.

The PTT has already distributed these terminals to the residents in Saint-Malo. Next year the PTT hopes to install about 250,000 directory assistance terminals in the Ille et Vilaine region.

Why electronic directory assistance terminals? At present, about 20% of the French population has telephones. But the French want 80% of the population to have telephones by 1990. To make this effort possible, the French PTT first had to improve one of the worst telephone services in the world.

Now that the French PTT can concentrate on installing more telephones, the need for more directory assistance operators arises. To avoid hiring more operators, the French decided to install electronic directory assistance terminals nationwide within a 10-year period. If the French opted to hire the operators and then decided to go with the terminals, the labor laws of the country would have forbidden the firing of the operators. Either way, opposition to this program has begun in France.

Also, the French believe that 30 million terminals distributed within the next 10 years will be cheaper than printing and distributing both the white and yellow pages of the telephone directory. At present it costs the French PTT about $230 million a year to print telephone books. Although the proposed directory assistance terminals will cost the PTT less than $100 apiece, users will have to pay a tariff on the calls they make.

By handing out a massive number of free terminals, the French should develop some capability in LSI technology. The underlying motive for developing this LSI technology capability would put France in a position to compete with the U.S., Japan and others when it comes to telecommunications. Based on this assumption, the French have decided to seek "collaborations and experimentations" with both private and governmental foreign organizations.

A nonprofit company called Intelmatique has been set up by the French government as the exporter of French viewdata expertise (Teletel). In December 1980, Intelmatique and Tymshare, Inc. agreed to explore "future business ventures" in the U.S. In the U.S. a company called Antiope Videotex Systems, Inc. markets the teletext version of the French Antiope system. Sofratrev, a partially owned subsidiary of the TDF, owns Antiope Videotex Systems, Inc.

Also France has set out aggressively to export 30% of its telecommunications equipment by 1982. The U.S. undoubtedly looks like a good customer. In the U.S., France Telecom, Inc. in New York, which represents the French PTT, actively promotes the country's telecommunications products.

Meanwhile, the French plan to invest a whopping $27 billion during the next five years to become the "Charlemagne of the wired nations." If the French don't succeed, the country will still have the best directory-assistance service in the world.

Each character position on the Ceefax and Oracle screen is tied to a specific position in the television line that is used to broadcast each 40-character row of digitized data. This fixed-format technique requires that transmission be geared to a particular time-slot on the television signal. Received Ceefax information finds its place on the screen by keeping track of the time at which the signal entered. The Ceefax "transmission and control and display language" is not separable from the transmission technique and is usable only on the television signal.

Antiope, on the other hand, uses a data packeting technique designed for carrying digital data on television lines. A page of information is formatted for transmission in individual, identifiable packets. Each sequentially assembled packet may contain up to 20 characters. Each line in the vertical blanking interval can carry several packets; thus, the line can carry more or less than 40 characters. Because the position of the data on the vertical blanking interval line is independent of the position of that data on the display, Antiope is referred to as a variable-format system.

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PEGGY KARP
has been involved in packet-switched networks since the early days of the ARPANET in 1969, and is a recognized authority on CCITT standards. As Executive Director of Product Engineering, she is responsible for the design and specification of new products and interfaces for GTE Telenet public and private network systems.

DONALD WEIR
has had extensive experience in the specification and implementation of packet-switching protocols. He is currently Director of Research and Planning for GTE Telenet, where he is responsible for the planning, system design, and development of advanced products, including packet radio, broadcast satellite, and megabit lines

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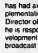

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"Like the man in the fairy tale who went to see the Queen, the Canadians got distracted by Prestel, not the Queen."

The Antiope "transmission control and display language," which is separable from the transmission technique and is DP-compatible; controls the fixed format. This feature means that an Antiope-adapted television set can receive digital data either via broadcast (teletext) or telephone lines (viewdata). Both the Teletel terminal and the directory assistance terminal will make use of the Antiope language.

The present Antiope character set can be supplemented to include Cyrillic, Arabic and Greek. Additional characters and graphics can be downloaded by the videotex center into the Antiope-adapted decoder's RAM. The downloading can be done via broadcast or the telephone lines.

In July 1979 the Consultative Committee for International Telegraph and Telephone (CCITT) adopted the British Prestel and French Antiope (Teletel) systems as international standards for viewdata.

Although Antiope Videotex Systems, Inc. has not made monumental sales, the company has actively placed Antiope systems in teletext environments. Antiope teletext activity in the U.S. includes the following:

- CBS has conducted extensive engineering tests using Antiope as well as Ceefax.
- KCET, a public broadcasting service station in Los Angeles, uses Antiope to test teletext and develop educational uses for teletext.
- WGBH uses Antiope as a means of providing CBS caption programs for the hearing-impaired.
- KNXT, a CBS-owned television in Los Angeles, will conduct tests of teletext this April.

In summary, Antiope has had a better reception in the U.S. than Prestel.

Canadian Concoction

Some Canadians would like to think they had videotex premonitions long before the British. But the BPO's jubilation over Prestel inspired the Canadians to go to London. Like the man in the British fairy tale who went to see the Queen but got distracted, the Canadians got distracted by Prestel, not the Queen. They returned home to take a different approach to videotex.

In the early '70s a report issued by the Canadian Computer Communications Task Force outlined the use of combined computer communications systems to provide universal access to the storage and processing capabilities of data bases.

Because of this report, a group of researchers at the Communications Research Center (CRC), part of the Department of Communications (DOC), began working on the communications of graphics images via the telephone lines. Wanting to avoid transmission delays incurred by the telephone lines, the research group had the task of devising highly efficient methods of communications. Software products that allowed graphics images to be rapidly and easily created and transmitted resulted from the group's efforts.

The Department of Communications in 1976 licensed Norpak Ltd. of Ontario to use the CRC software for the development and sale of commercial graphics terminals. The following year the British Post Office's Prestel service grabbed the attention of the Department of Communications.

To evaluate the significance of the British development, an engineer from CRC created a system similar to Prestel based on the experimental graphics system. A week later, a demonstration of the Prestel look-alike system took place. Despite the outcome of the demonstration, the engineers at CRC continued to develop a videotex system. Meanwhile, a prototype videotex system being used for briefings gained the attention of the Minister and Deputy Minister. But interest in videotex didn't get going in Canada until the summer of 1978.

On Aug. 15, 1978, the Department of Communications announced a videotex system capable of being used in both the viewdata and teletext modes. But the announcement went unnoticed because of similar developments that were brewing: Bell Canada had developed a copy of the British Prestel system; a Canadian company contemplated purchasing the French Antiope system; and another company expressed interest in licensing the Prestel software. The intensity of the heat from this preliminary videotex activity made the Department of Communications rally for a properly funded program.

On Dec. 7 the Department of Communications' videotex development received the trade name Telidon. The "idon" comes from the Greek words "I perceive," and "tele" means "far away."

Enthused over Telidon, the Canadians proposed that the CCITT adopt the system as a viewdata standard. Although Telidon was supposedly two years ahead of Prestel and Antiope, the CCITT turned down Telidon.

Field Trials

The Consulative Committee on the Implications for Canadian Sovereignty issued a report in March 1979 strongly supporting Telidon. The Science Council of Canada and Communications Research Advisory Board gave their support to Telidon. This combined support caused the government within one month to approve $9 million for a four-year program of Telidon field trials and development of the system's components. Up until this time, $2.4 million dollars had been invested in the Department of Communications' videotex developments.

Between May and July of 1979, four companies announced significant trials using Telidon. The Alberta government agreed to use Telidon in a field trial called Project Vidon to begin in 1980. The Manitoba Telephone System announced that it would include Telidon in Project Ida — a test of telephone, cable television and videotex services via a single coaxial cable. The Ontario Educational Communications Authority expressed an interest in using Telidon in the broadcast mode. And Bell Canada announced that it would Telidon technology in Project Vista in 1981.

By June 1979, more than 100 Telidon prototype terminals were in operation across Canada.

With all the takers for Telidon, Torstar and South Press, two Toronto newspaper publishers, announced the formation of a jointly owned company called Infomart. Acting as an information service provider for Telidon field tests, Infomart would create pages for a company not having the expertise or proper equipment and would arrange to have the pages included in a variety of data bases.

Because there are no PTTs in Canada, the Canadian government decided to act as a catalyst for videotex services rather than as a provider of them. Thus the adoption of Telidon by interested parties resulted in a volunteer effort.

Representatives from common carriers, the cable television industry, broadcasters, information providers, equipment manufacturers, public service organizations and government

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"As a videotex service, Telidon differs from the European systems in number of lines and in higher quality graphics."

formed the Canadian Videotex Consultative Committee. During the first meeting in November 1979, the committee reached an agreement on how viewdata and teletext standards would be coordinated among the national and international standards bodies. Also, the committee established a subcommittee to investigate legal issues, the effects of videotex on individuals and society and an industrial strategy.

A week after the committee meeting, potential information providers formed the Videotex Information Service Provider Association (Vispac).

Telidon vs. European Systems

A videotex service using Telidon in either the viewdata or teletext mode functionally resembles the European services. As a videotex system, Telidon differs in two ways from the European Systems. Because the number of lines available on a U.S.- or Canadian-made television set is 525, the Canadians decided to use a format of 20 rows of 40 characters rather than 24 rows of 40 characters. Also, Telidon's unique graphics capability offers significantly higher quality graphics than the European alphamosaic approach.

Creating graphics using the alphamosaic approach resembles the artwork of George Seurat, the French Impressionist painter. Seurat composed a picture by dabbing the canvas with millions of dots of color. Called pointilism, this technique caused figures to look "grainy.".

With the alphamosaic approach, each character position on the page represents a fixed number of rectangles. Graphics are accomplished by subdividing a rectangle into a two-column by three-row matrix. The 64 combinations of the matrix that are available define the various graphic patterns that can be used to build a drawing. Each of the 64 graphics codes, along with color attributes, can be accessed from an editing keyboard by using a supershift command.

If Seurat were to create a videotex picture, he would be dabbing combinations of rectangles. He could build the drawing right on the editing terminal display by typing out the appropriate graphics codes and the color attributes. He could even reposition the graphic or make it smaller. However, Seurat would find this approach just as laborious as pointilism.

However, Seurat could call a superimposed grid onto the display of the editing terminal, use a light pen to fill in the grid and press keys for attributes such as color.

With the Ceefax and Antiope systems, Seurat could be out of a job. Ceefax and Antiope allow a television camera to be focused on a hand-drawn graphic or photographs. The camera inputs its signals to a computer, which generates the appropriate alphamosaic graphics codes. Minor human touch-ups can improve the results. But this method cannot guarantee good resolution for detailed graphics.

Graphics images along with the text are transmitted as a sequential piece of a page. To create a page on the display, the page RAM in the decoder holds both the graphics codes and the text codes. However, both the graphics codes and text codes are fetched from separate read-only memories (ROM). Both graphics codes and text codes have a one-to-one relationship between their position on the screen and their position stored in the data base.

Alphageometric Approach

Telidon uses a high-level computer language that defines graphics with seven Picture Description Instructions (PDI). Four PDIs make up the basic geometric primitives of line, arc, polygon and rectangle. These primitives describe most graphics images. When these four primitives cannot be used to define an image, the Bit PDI draws the image point-by-point in a manner similar to a facsimile machine. The Point PDI is used to set the drawing position of the geometric primitives. The Control PDI is needed to change from graphics to alphanumeric or from alphanumeric mode back to graphics mode. The PDI instructions and alphanumeric characters are contained in 8-bit words (7 bits of data and 1 parity bit in each word) and comply with present standards over conventional data networks.

For example, to draw a line with a Telidon editing terminal, one uses a joystick to determine the starting point and end point of the line and then presses the appropriate button. The editing software draws the line.

A microprocessor in the Telidon decoder implements an interpreter program to expand the highly compact PDI codes into the bits, which load the page store's RAM.

The use of PDIs have several suggested advantages. PDIs can supposedly be converted into a level of resolution appropriate for the television set. PDIs offer a compact way of describing graphics on a page and storing graphics on the page in a data base. For example, upon receiving a request for a page, a computer just has to select the proper page and dump the stored PDIs to the output channel.

The Telidon alphageometric technique requires a decoder to have more memory in its circuitry than a decoder that handles alphamosaic graphics. Thus a high-resolution Telidon decoder could be more expensive than the decoders for European systems. But the Canadians plan to offer a range of decoders with varying resolutions and prices.

Project Vista

In 1979 Bell Canada did a 25-terminal pilot test of a Prestel look-alike system developed by Bell Northern Research (BNR). Bell Canada selected the name Vista for its pilot test and the trial test. The significance of the name conveys the "long-term impact and universality associated with a viewdata system."

For the pilot test, users in Toronto, Ottawa and Montreal accessed a 2,000 page data base which was stored in a Digital Equipment Corp. PDP-11/34 computer located at one of BNR's Ottawa labs. Torstar Corp. and Southam, Inc. (Infomart) donated the data base, which consisted of news, sports, weather, games and consumer information.

The goal of this test was to acquaint potential information providers with the capabilities of viewdata and to test their reaction as well as the reaction of consumers.

Because of the low resolution created by the alphamosaic graphics technique, Bell decided to abandon the design of the 25 terminals. In August 1979 Bell announced that it would use Telidon graphics technology in the terminals for the Vista field trial.

But Bell took another giant step and announced that its trial service would be a combined effort with the Canadian Department of Communications. Bell Canada, however, would pick up most of the $10 million tab for the venture.

The field trial of Vista, to begin in 1981 and end in 1982, will involve about 1,000 terminals in Toronto and Quebec City.

The Toronto information retrieval and switching center for the Vista trial will use a DEC PDP-11/70 on loan from the Department of Communications for the duration of the trial. The computer has 64 dial-up ports. Data transmission from the information retrieval computer will take place at 1,200 bit/sec, and data will be received at 150 bit/sec.

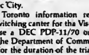
Norpak Ltd., which has a license to build Telidon terminals, will supply the BNR-designed terminals for the trial. The terminal will consist of a color television set, a separate control unit, which houses a decoder and a modem, and a hand-held keypad.

Bell Canada will distribute the terminals to a target group of users. This group was obtained by a marketing segmentation based heavily on the demographics of income, according to Gordon Johnson, assistant director of business development at Bell Canada. Johnson said that the target group consists of "households with two working parents or one working parent; homes with children were given preference. The segmentation was skewed to upper-income families."

Participants in the trial will have access to 75,000 pages of information in either French or English donated by 28 information providers. The Department of Communications has designed the data base software for the trial. The data base will resemble the tree-structure data in the Prestel system.

Like the Prestel decoder, the Vista terminal will feature an auto-dialer and an identification number that will be stored in programmable read-only memory (Prom).

The trial provides Bell Canada with the opportunity to evaluate viewdata services using high-resolution graphics, to evaluate both consumer and business information offerings and to evaluate the possibility of offering



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"Canada and France have signed a three-year Memorandum of Understanding on common research problems in research design."

Vista as a regular service.

The Department of Communications has supplied 40 Telidon terminals to the Manitoba Telephone System's (MTS) Project Ida in South Headingley, Man.

Besides providing viewdata information services to homes, Project Ida, which began in June, provides fire, cable television, burglar-alarm services and remote metering. These services are provided via a coaxial cable.

Information providers for the Telidon test include Infomart of Toronto, the *Winnipeg Tribune*, Cybershare Ltd. of Winnipeg, Man., and the University of Manitoba. Norpak Ltd. manufactured the Telidon terminals used in this test.

Telidon Trials Go On

In early 1981 the New Brunswick Telephone Company will begin its Project Mercury, a two-year Telidon viewdata field trial.

The Alberta Government Telephone will begin its Telidon field trial, called Project Vidon, in late 1980. The trial will use 150 terminals.

The British Columbia Telephone Co., the second largest telephone company in Canada, plans to conduct a variety of Telidon field trials on the Canadian West Coast during 1981 to 1983. The Ontario Edocational Communications Authority (OECA) has been testing Telidon in the broadcast mode since January 1980.

The Canadian-French Connection

On Oct. 12, 1979, the Canadian Communications Minister and the French Ambassador to Canada signed a three-year Memorandum of Understanding on common research problems concerned with videotex systems design. The agreement will increase cooperation between the two countries at the videotex research level, not the commercial level. Terms of the agreement call for the exchange of specialists, equipment, information and expertise between the two countries.

In November 1980, a study group submitted a recommendation of Telidon to the full organization in Geneva. The CCITT approved Telidon as another international viewdata standard.

Like the European countries, Canada intends to export as well as exploit Telidon throughout the world, especially in the U.S. Why? The Canadians, like the French, want to position themselves for the future.

As Bernard Ostry pointed out at the Inside Videotex Conference in March 1980, "The future of industrial life everywhere is tied to the chip. Any industrialized country which fails to recognize and prepare for this could face severe economic dislocations." Ostry is currently Deputy Minister of Communications in Ottawa and a member of the Prime Minister's Task Force in Government Information.

In July 1980, the National Science Foundation, the Corporation for Public Broadcasting, the Department of Commerce's National Telecommunications and Information Administration and the Department of Health, Education and Welfare funded a $1 million project to test Telidon in the broadcast (teletext) mode.

Scheduled to begin April 1981, the test will be conducted at WETA-TV in Washington, D.C., and will be managed by the Alternate Media Center of New York University. Because WETA is a noncommercial station, the test will not feature advertising. Information providers include the *Washington Star*, the *Washington Post* and public and government agencies.

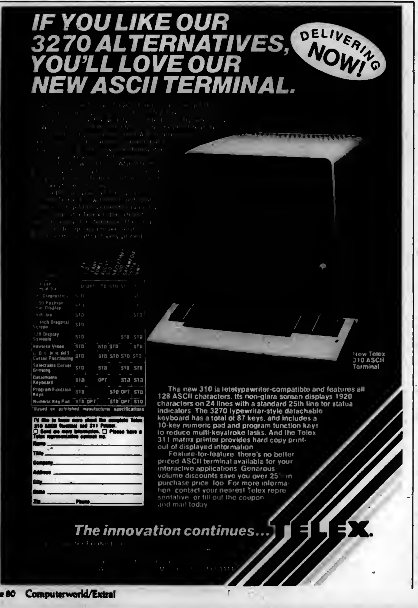
The 60 terminals purchased for the test are manufactured by Norpak Ltd. Each $1,300 terminal will be rotated to selected homes in the Washington, D.C., area for the next two years. The aim of this test is to evaluate consumer interest in teletext offering, not the technology of Telidon. The parties involved have already evaluated the potential of teletext.

In July 1980, the Venezuelan government announced a Telidon viewdata test to begin in early 1981. The country's telecommunications department has ordered equipment worth $750,000 from Infomart. In turn, Infomart will provide a complete Telidon system and train Venezuelan technicians. This test is Canada's first sale of Telidon to a foreign country.

Videotex in the U.S.

Regulation and ownership of all communications services in the U.S. exists among a number of parties, and the Federal Communications Commission (FCC) tries to regulate all these services. Ownership of communication services belongs to AT&T, GTE Telenet Communications Corp. and dozens of independent telephone companies plus the U.S. Postal Service, Western Union, broadcasters, cable television operators and other types of common carriers.

With laissez faire being the climate in the U.S., massive government spon-



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"A hodge-podge of viewdata and teletext services exists in the U.S. despite the lack of government funding."

sorship for a viewdata service, such as Prestel, seems unlikely. Instead, the private sector will have to foot the bill for consumer or business viewdata-type services. On the other hand, the FCC's deregulation of AT&T's activities means that private companies setting up viewdata services might get some competition.

Teletext Takers

Looking at teletext services in Europe, one finds a single network entity with a government mandate. In the U.S., three major networks — NBC, ABC and CBS — reign, along with thousands of affiliated private broadcasters. Regulated by the FCC, private broadcasters and major network broadcasters exist as profit-making entities.

A hodge-podge of viewdata and teletext projects exists in the U.S. despite the lack of government funding. But, looking at these activities, one finds either a Prestel, an Antiope, a Ceefax, or a Telidon system, or a system that bears a striking resemblance to one of the four.

Knight-Ridder's Service

Apart from GTE's and Aregon's viewdata activities in the U.S., Knight-Ridder Newspapers, Inc. has ambitiously followed suit. The Florida company publishes 32 daily U.S. newspapers, which include the *Miami Herald* and the *Philadelphia Inquirer*. The company also owns four television stations.

In 1977 the activities of the BPO and BBC prompted Knight-Ridder officials to journey to London. The new mass communications development — teletext and viewdata — mesmerized the Knight-Ridder officials. They felt that a teletext service offered a too-limited data base and no large revenue for advertising. But a viewdata service offered a subscriber an infinite amount of data and the potential for two-way buying services. However, the officials could not measure the impact these services would have on the U.S. consumer. They returned home with the idea of some day conducting a test similar to the emerging BPO's Prestel.

As Knight-Ridder's plans for a viewdata service blossomed, the company's officials continued to monitor similar developments abroad. In 1979 Knight-Ridder formed a subsidiary called Viewdata Corp. of America. The subsidiary would carry out a test service in 1980 called Viewtron.

Although the Viewtron trial did not require FCC approval, Knight-Ridder decided to make AT&T a major participant in the service. AT&T's Southern Bell subsidiary agreed to provide telephone links in Coral Gables, Fla., the test location. AT&T's Bell Laboratories designed the terminals, and Western Electric Co. manufactured them.

Meanwhile, Viewdata Corp. of America designed the data base software, rounded up information providers and interviewed test participants.

On July 14, the Knight-Ridder/-AT&T Viewtron trial service to measure consumer interest in home information went into operation for six months. The 30 AT&T-designed terminals would spend several weeks in each participant's home.

The 15,000-page data base for the test is divided into Home Information/Management Services and Home Transactions.

The Home Information/Management Services data base consists of news, sports, consumer information, games and quizzes. The information providers for this section include the *Miami Herald*, the *New York Times*, Dow Jones Co. and the *Wall Street Journal*.

The Home Transaction data base, which has 16 advertising information providers, allows each participant to go teleshopping.

Another feature of the Home Transaction service is the bulletin board. Using the typewriter keyboard attached to the terminal, participants can place classified ads, can send another participant a message or can write a letter to the editor.

Each family member in the trial has an individual ID number and a confidential password. Users can access Viewtron pages via a menu or a numbered option. Unlike Prestel, Viewtron users can access any page by typing in one of 100 keywords, such as travel, sports or "Sears."

Mort Goldstrom, marketing manager of Viewdata Corp. of America, volunteered to become one of the participants in his company's Viewtron trial service.

The service, unlike traditional television, let Goldstrom "get the news whenever" he wanted. "I didn't have to waste 27 minutes just to get 3 minutes of news. One does not sit around the television reading videotex as if one were watching a television screen."

Like most viewdata/teletext trials, the participants are getting all information

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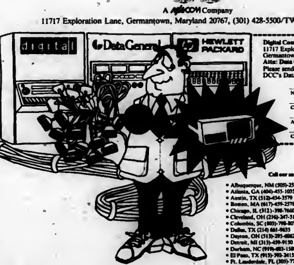

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"Although AT&T played a leading role in the Knight-Ridder experiment, the telephone company has a larger project in the wings."

and services free. The advertisers and information providers just contribute the information. But what is going to happen when people have to pay for these conveniences? When it comes to this question, Knight-Ridder seems to be using reverse psychology, according to Goldstrom. He said that "the company wants to see if people will look at viewdata under any conditions."

Although the $2 million trial ended on Jan. 14, the company decided to extend the trial. This move postponed Knight-Ridder's and AT&T's revealing what they leerned. A second trial will probably be conducted to see how much consumers want to pay for the service.

In the U.S. today, a data base company exists for just ebout every subject imaginable.

Apart from the video display used to access information, data bese services resemble e viewdata service. But one could turn a television into a computer terminal by adding e microprocessor, memory and a storage device. For example, an ordinary television set functions as a display monitor with an Apple Computer, Inc. home computer. Because of these developments, the term viewdata in the U.S. becomes e euphemism for time-sharing.

The growth of microcomputers has caused data base marketers to concentrete on pushing their information to the emerging home information market. And whether or not one calls these services viewdate, they provide the consumer with the same types of information.

Although AT&T played a leading role in the Knight-Ridder experiment, the telephone company has e larger project in the wings.

In 1979, AT&T end the New York Telephone Co. conducted en Electronic Information Service in Albany, N.Y. The company installed telephones with video displays end typewriter keyboards in the homes of participants. As with the French directory assistance terminals, U.S. participants can access either White or Yellow Peges' information and receive the requested information only, not the whole page. The deta base in the Albany test resembles the one used by telephone operetors.

Later this year, AT&T will conduct its Electronic Information Service in Austin, Texas, for 14 months. The terminals will be placed in 680 homes for three months end in 60 businesses for six months. Like the Albany trial, participants will have access to both the White and Yellow Pages' information.

The future of the Electronic Information Service became a reality in April 1980, when the FCC gave AT&T the order to deregulate its activities. Congressional bills before the House acknowledged thet AT&T should be allowed to enter the new end unregulated markets beyond its traditional telephone service.

With the blessing of the FCC, AT&T plans to restructure itself into two entities. One part of the restructured company will handle AT&T's traditional telephone service and will continue to be regulated. The proposed entity will sell e slew of equipment end services — telephones, directory assistance terminals and services and Advanced Communicetions Service, which was proposed in 1979.

But the American Newspaper Publishers Association (Anpa) did not like the idee of AT&T offering an electronic directory assistance service. Members of Anpa ergued that AT&T could get into the business of producing information as well as cerrying it over the telephone lines. To stop Anpa members from lobbying against pessage of legislation to further deregulate AT&T, e representative from Colorado introduced an amendment prohibiting AT&T from getting into services that would, in effect, duplicete newspapers or their classified ad sections.

Will this legislation bar AT&T from offering electronic Yellow Pages and classified advertising? James E. Olson, vice-chairman of the new Bell entity cannot believe that Congress would pass e bill to allow everyone but Bell to use the latest technology relating to this type of an information service. One need recall thet AT&T invented the Yellow Pages.

Olson wants to get AT&T into the growing telecommunicetions field as soon as possible. In e *New York Times* interview last August, Olson said, "We do not intend to allow cable operators or others to come in with electronic Yellow Pages while we stay with print — and any law that compels us to do that is e bad law."

Like the Anpe members, officials of DP companies are also lobbying to keep AT&T off their turf.

Teletext in the U.S.

At the end of 1979, the U.S. populetion of 220 million individuels comprised 71.5 million television households. In February 1970, the average

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> **"One can infer that the broadcasting industry might have an interest in teletext. But first approval from the FCC is required."**

household watched 37.4 hours of television per week. By February 1980, the average viewing time had jumped to 44.8 hours per week, according to Arbitron Research Co. In 1977, the U.S. had about 1,000 individually licensed television stations, 25% of them nonprofit. The broadcasting industry reported revenues of $5.9 billion at the end of 1977; pretax profits for that year were $1.4 billion.

Looking at these figures, one can infer that the broadcasting industry might have some interest in providing teletext services. But before an over-the-air service can be offered in the U.S., one needs approval from the FCC. The FCC has to issue a transmission standard before a new broadcasting service can be tested or put into full operation.

In 1977, representatives from the BBC and the French company Sofratev demonstrated their teletext systems in the U.S. A demonstration caught the eye of a representative from station KSL-TV in Salt Lake City. In June 1978, the station, owned by Bonneville International Corp., obtained permission from the FCC to begin a test of the BBC's Ceefax system.

Decoders were placed in homes of participants in the Salt Lake City area. Participants could obtain news, weather, sports, stock information and airline schedules.

The test has provided KSL with answers to technical as well as human questions. The station has determined that the magazine should be kept to 100 pages to obtain a maximum wait time of 15 seconds.

In March 1979, CBS received permission from the FCC to conduct tests of teletext. CBS used its KMOX station in St. Louis to test a modified version of the fixed-format Ceefax system and a modified version of the variable-format French Antiope system.

After the CBS tests began, the Electronics Industry Association (EIA) established a subcommittee on teletext. The subcommittee consisted of representatives from the three major networks, major television stations, broadcast equipment manufacturers, television set manufacturers and integrated circuit manufacturers.

The goals of the subcommittee were to study teletext services and derive a 75% majority of committee votes on a single set of technical standards. The selected standards would become the basis for a Petition for Rule Making to the FCC.

To adopt a teletext standard for U.S. television, the subcommittee had to weigh the following factors in a system: transmission standards, format standards and feature and decoder options. The transmission standard included the bit frequency rate and available vertical blanking lines that should be used in the video signal. The format consisted of the number of characters per row and the number of rows per page. The featura and decoder options consisted of specific features, such as color and size of letters, to be included in the decoder circuitry.

The subcommittee was to evaluate the three teletext systems — Telidon, Ceefax and Antiope — by these factors. For almost a year, subcommittee members met regularly to see demonstrations of each system, read countless results of test reports and generate documentation based on each member's committee assignment.

In mid-July 1980, CBS broke from the EIA subcommittee and petitioned the FCC to adopt a modified version of the French Antiope system as the U.S. standard for teletext. In its petition, CBS stated that the variable format of the French system offers more flexibility than the fixed format of the British system. The French system also offers more compatibility with viewdata than the British system, CBS claimed. Although CBS did not evaluate the Canadian Telidon system, the report stated that the PDIs used in the Telidon graphics technique would make the cost of a decoder too expensive for a consumer. CBS did not test Telidon because the equipment supposedly was not available.

A week later, 23 members of the EIA subcommittee failed to reach a 75% majority vote on a system standard. The committee members cast nine votes for the British system, five votes for the French system and one vote for the Canadian system. The CBS move had left the EIA subcommittee in a quandary.

"The information available to CBS from its field tests and its enthusiasm have propelled it to believe that there is no need for further investigation and that the Antiope system will do the job," said EIA subcommittee chairman Dr. Walter Ciciora of Zenith Corp. Ciciora said, "There are others who disagree with CBS and feel that other systems are more logical and more appropriate."

Ciciora believed that the present Antiope circuits would have to be re-

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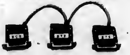
Diagnostic Loop Back Cables



Loop back diagnostic cables provide for routing all output signals to all input signals. An error condition will be indicated as a specified test number and displayed by the seven segment LED. Further actuation of the diagnostic test switch will allow for fault isolation to the "chip" level. This fault isolation technique eliminates classical "finger pointing" when the network goes down.

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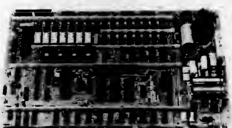

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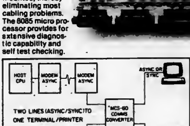

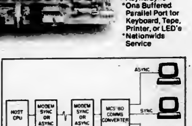

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"Within the next five years, governments and private organizations will pour billions of dollars into videotex developments."

designed for U.S. television standards, and that could mean an expensive decoder. On the other hand, Ciciora said that the British have a large supply of circuits available that "can be adapted to teletext in the U.S."

However, Ciciora added, "There is still a need to resolve some very critical issues before we take a firm stand. There have been a lot of partial resolts available that are ambiguous," Ciciora is quick to point out that the EIA subcommittee is serving as an industry task force to assemble the information on a very complicated subject and preferably come up with one recommendation. If this is not possible, then a clear statement of what's possible with as much scientific evidence."

When is the EIA subcommittee going to reach a decision on a teletext standard? Ciciora said, "mid-year 1981. The FCC is the only one that can make a binding decision. It is my fond hope that the FCC will await the EIA's recommendation before making a decision." On the other hand, the FCC could adopt any standard it desires, even a recommendation from the cable television industry.

Even if the FCC comes up with a standard, no one can verify what a decoder will cost the U.S. consumer. Ciciora did not want to comment on a price.

Videotex and Cable TV

At the end of 1979, 20% of the 71.5 million television households in the U.S. had community antenna television (CATV), more popularly called cable TV. Quantum Sciences Corp., a consulting firm, forecast that by 1985, 20% of all U.S. homes will have CATV. At present, more than 4,100 operators provide this service.

As a vehicle for videotex services, CATV has excellent potential. CATV can carry both viewdata and teletext transmission.

"The telephone company is set up for a maximum baud rate of 9.6 bit/sec on a twisted pair," said Chris Weaver of the National Cable Television Association (NCTA). Weaver said that the transmission limit of cable is "almost infinite and almost unmeasurable."

When it comes to teletext transmission via cable television, one has to abandon the word "broadcast." As Weaver said: "When a signal is broadcast, it radiates in all directions. With cable TV, the correct term is 'narrowcast.' When one narrow-casts, the signal radiates in one direction, namely inside the cable. Narrow-casting protects the teletext transmission, especially data inserted in the vertical blanking interval. Cable television allows a whole channel to be set aside for teletext transmission." Thus, a magazine with 10,000 pages or more can be continuously cycled and retrieved.

Permission to operate a cable television service is granted from the FCC and from a state or municipal authority. Unlike regular broadcasters, cable operators are not legally bound by transmission standards and they can allocate full channels to nonprogramming services.

Mark Plakias of Link Resources Corp. predicted that "plenty of videotex experiments with [CATV] will be conducted in 1981." From the look of things currently, the tests mostly involve transmission of teletext. Most of these tests will involve a major newspaper feeding news, weather and sports to local cable stations.

End of the Tale

Within the next five years, governments and private organizations worldwide will pour billions of dollars into videotex developments, trials, experiments and projects. Will these developments guarantee that videotex will develop into a profit-making entity? What will be the social impacts of these developments?

When it came to newspapers, Napoleon commented: "Cannon fire killed the feudal system, ink will kill the modern social organization." In the 1870s an official of the BPO aired his feelings about the "telephone invention" to a reporter from *The Times* of London: "They have need of it in the colonies, but in England we have an abundance of messenger boys." In 1927, a headline in *The New York Times* heralded the birth of television: "Far-Off Speakers Seen as Well as Heard Here in a Test of Television . . . Commercial Use in Doubt."

It just happened that once these inventions were pursued as a business enterprise, they became commercially viable. Of course, this scenario did not exist for every invention. AT&T won't forget its Picturephone. The company swore that Americans wanted to have a telephone with a little screen attached so they could gaze at one another while they chatted.

Americans enjoyed gazing at each other via Picturephones at the 1964 World's Fair, but consumers found them too expensive for everyday usage. Need one say more? ◆

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Lease	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
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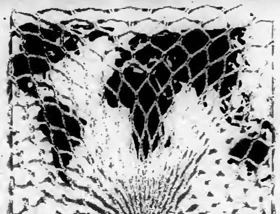
By Howard Frank

TELECOMMUNICATIONS: 1970 1990



Today's network communications trends originated in the mid-1960s when users began to utilize computer resources remotely over long-distance telephone lines. To do so, they built primitive networks that improved the use of computer resources, but did not provide for comparable efficiencies in the use of communications facilities. Communications costs began to increase rapidly, forcing planners to search for means to increase network efficiency.

One method that came out of this search was sharing the cost of a single communications line among several terminals. This was practical because the average amount of data sent from a typical low-speed terminal is much smaller than the capacity of the line needed to accommodate its peak requirement. However, to share lines effectively, protocols had to be constructed to resolve the contention problems that arose when several terminals simultaneously attempted to gain access to the host processor. This added complexity to the planning process and to the central processor software. It also produced incompatibility among the various approaches chosen by different terminal and mainframe vendors, since their protocols were usually developed ad hoc, with no attempt made at consistency within the industry.

To Offload Processing

In parallel with early network developments, the front-end processor appeared as a new network component. Primarily because of low-cost minicomputer technology, this device has become a frequently encountered element of the modern teleprocessing network. Its role is to reduce processing overhead in the central processor by absorbing some of the network control functions, to simplify development and modification of mainframe communications software and often to accommodate specialized communications processing better done outside the primary processor.

Moreover, some manufacturers have begun to address the protocol incompatibility problem by incorporating protocol translation elements within the front-end software. Others, like IBM, have attempted to solve this problem by creating a standard set of protocols and relying on systems evolution to standardize access methods.

Additional network developments resulted in the introduction of multiplexers and concentrators as a means of cutting communications costs. These devices lower the cost of transmitting data by taking advantage of economies of scale available from the transmission carriers and modem manufacturers, thereby permitting many low-activity terminals to share a much smaller number of long-haul communications lines. Thus, the lines' transmission capacity is utilized with greater efficiency, and the average cost per bit of transmitted information is lowered.

The present structure of most commercially operated networks often contains several levels of concentration ranging from simple multidrop polling to complex multiplexing schemes. Such networks contribute to lower cost because when using leased facilities, one pays for communications capacity whether it is used or not. Further, the breakpoint between dial and lease services usually encourages the latter after several hours of connect time. Thus, tariffs and technology offer economies of scale, but force us to structure our networks in complex arrangements to achieve these economies.

Today's data communications system is likely to contain a wide range of devices including terminals (dumb, smart or intelligent), interfaces, modems, multiplexers (static or dynamic), concentrators, front ends, message processors and computers (mini, micro, mono or multi).

Ten years ago, most of the concepts embodied by these devices existed, but few practical, cost-effective components had been built. Major developments over the last decade include the emergence of low-cost statistical (dynamic) multiplexing/concentrating devices, the offloading from hosts of communications functions into special purpose mini- and microprocessors and the development of network control and diagnostic systems. Along with the emergence of network devices have been new network structures to allow users to use these devices to achieve lower overall cost or better performance.

Acceptance of Packet Switching

As the need to access computers and remote data bases became widespread, techniques evolved to facilitate communication between computers. The first communication schemes developed for this purpose involved the physical transport of a tape from one computer to another. Another means for transfefring data between computers involves the use of message-switched systems to connect the low-speed CPU ports (typically teletypewriter-grade) through an on-line computer called a message switch.

Most users are familiar with the classical "centralized" teleprocessing system which originally consisted of a processor connected by leased or dial-up lines to terminals. Doring the last 10 years, this structure has evolved to include front-end processors, multiplexers, concentrators, remote satellite processing units, control units and terminals. Such a network, while still generally classified as a centralized system, is in reality a "distributed" system. However, today the word "distributed," when used in the context of networking, generally evokes the term "packet switching."

Packet switching combines several innovative approaches for handling data with current computer technology to provide significant enhancements to computer networking. Packet switching operates by allowing messages to be broken up into segments called packets, attaching addresses and other information ooto the packets, queuing the packets and then guiding them along multiple independent paths from origin to destination. Message transfer need not be conducted under centralized control. At the destination point, the packets are reassembled into the original message. If the network performs well, the process is virtually transparent to the user.

Packet switching is almost entirely a development of the 1970s. Pioneered

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Howard Frank is president of Network Analysis Corp., Great Neck, N.Y.

"Without transmission breakthroughs, sufficient capacity within frequency bands may not be available for all services."

by the Advanced Research Projects Agency of the Department of Defense (Arpa), the Arpanet began life in 1969 on the West Coast as a four-node network. By 1975, Arpanet interconnected more than 100 computers of diverse manufacturers through a network of more than 50 minicomputer-based packet switches. Today, packet-switched networks are providing data communications in the U.S., Canada and Europe with numerous networks now being planned as public or private offerings.

Common Base

One characteristic of a packet network is that its many computers communicate through the use of common network languages and protocols. For example, the network nodes contain a virtual terminal protocol with which a variety of different terminals can find a common base for communications. The processors within the system (generally mini or multiple microprocessor configurations) allow the conversion of the local terminal language to the network virtual language and, at the destination, conversion into the language of the supporting computer.

A second major characteristic of packet-switched networks is the ability to achieve high utilization of the communications lines via the natural multiplexing ability of packet switches which, in this mode, perform much the same function as a concentrator. These two features, along with packet switching's adaptive routing potential allowing reliability superior to more classical approaches, are largely responsible for the rapid commercial acceptance of the technology during the last few years.

Current trends are combining the classical bandwidth-sharing techniques of centralized systems for optimizing local and regional communications with packet switching for "backbone network" optimization.

Rise of Vendor Architectures

During the early 1970s, nearly all data communications systems were built by the mainframe computer vendors. These networks were generally developed to support application systems running on the vendors' hosts. Obviously, data communications software systems developed by different manufacturers were bound to be incompatible. However, even the software systems developed to support different applications of the same manufacturer were generally incompatible with one another. The result, throughout the industry, was multiple networks of incompatible terminals often connected to the same host and terminal locations. IBM was the first major vendor to respond to this problem by announcing in 1974 its Systems Network Architecture (SNA).

Before the introduction of SNA, IBM had more than 200 communications products requiring 35 teleprocessing access methods and 15 different data link control procedures. The goal of SNA was to provide a unified approach to IBM networking by introducing a single standard host access method and link control procedure. The use of these standards would achieve terminal compatibility at the communications line level as well as independence between network devices (such as terminals) and host applications. This represented a major step forward in IBM's recognition of networks as a vital element of computing systems, as well as an important internal step toward IBM reducing its cost to maintain and support multiple communications software systems.

The advantages of SNA are derived primarily from the use of a consistent, unified architecture in place of the ad hoc procedures of the past. Use of full-duplex terminals (based on IBM's Synchronous Data Link Control [SDLC] protocol) allows more efficient utilization of communications lines, yielding fewer lines and lower line costs. Independence of applications and network hardware, including terminals, permits different applications to use the same terminals, reducing the number of terminals needed to perform a set of functions. Furthermore, a somewhat reduced load on the main CPU can be achieved through offloading to front-end processors, controllers and intelligent terminals

Disadvantages Eased

The original disadvantages of SNA related primarily to three factors: 1) the cost of increased memory and processing at the host; 2) the cost of upgrading from more primitive terminals; and 3) the conversion costs incurred by moving to a full SNA implementation.

Moreover, IBM began its marketing of SNA by trying to convince its users to adopt SNA on a full-scale basis rather than through an evolutionary approach that would allow both SNA and non-SNA applications to coexist within the same central processor. Developments over the last two years have reduced these disadvantages considerably.

Thus, the SNA of the 1970s can be viewed as IBM's first step to develop a viable networking approach for the 1980s. This networking approach is adopting, where appropriate, many of the concepts of packet switching and will ultimately provide the same range of network capabilities as the leading-edge packet systems.

Since the introduction of SNA, many other vendors including Digital Equipment Corp., Burroughs Corp., Sperry Univac, Comten, Inc., Computer Communications, Inc.; Raytheon Data Systems Co., Prime Computer, Inc. and Data General Corp. have all introduced their own network architectures. Some of these, such as DEC's Decnet, have already achieved considerable maturity. Others were only announced within the last two years and are now under development.

Thus, the last decade can be considered as the period when vendors recognized the problems implied by large-scale data communications systems and began the activities required to correct them. The fruits of these activities are yet to be fully realized. During the next few years, concentration of vendor attention will be on basic capability development. Thereafter, the ability to communicate between vendor offerings will slowly develop via basic standards currently being adopted or devised.

Value-Added Networks

One of the most exciting developments of the last few years has been the emergence of the value-added network (VAN). A VAN can be distinguished from a classical common carrier because it need not build transmission facilities. Instead, it uses conventional common-carrier facilities and combines them with specialized message-processing services which add "value" to the network.

VANs currently operating within the U.S. include GTE's Telenet, Tymshare's Tymnet and ITT's Faxpak, while those in Europe include Transpac and many other systems. Telenet, Tymnet and Transpac provide data communications service, while Faxpak currently serves facsimile terminals. ITT's plans include extension of Faxpak services to data communications.

Until recently, users thought of networks as transparent channels that simply accommodated bit streams from origin to destination, with all special features incorporated at the endpoints of the network. If the user wished to add an error-correction scheme to protect his data, he built it into the processors or front ends. Similarly, a code conversion scheme would be built into the sources and destinations. By using minicomputer switches, a VAN introduces these services into the switching nodes so that the network is no longer a transparent system.

The VAN gives the user a ready-made backbone network (a resource that might be too expensive to be developed independently by the small user). The user's network problem then becomes one of achieving access to the VAN through the appropriate interfaces and his own local distribution network.

Growth in Access

Today's VANs have increased rapidly in their number of access locations and within the next decade should provide convenient access for a majority of the population of Western Europe and North America. Currently, most data service is for low-speed (up to 1,200 bit/sec asynchronous terminals. However, synchronous service on a limited basis is now available and, within the next few years, should be widespread.

However, today's VAN represents only a minimum resource compared with the data communications utility required by tomorrow's user. The next step in the evolution is the attachment to the VAN of additional value-added services such as message and mail services.

By 1990, numerous new electronic services including store-and-forward voice will be available. This latter feature will probably be introduced into the VAN services during the 1983-1985 period. Preceding the widespread use of voice store-and-forward services through packet networks will be the introduction of low-cost voice coders (vocoders) to allow quality transmission of voice signals at less than 9.6K bit/sec. Such devices should be available by about 1983 and will also find substantial application in reducing long-distance telephone costs through voice multiplexers.

Another important recent development is the emergence of domestic satellite carriers which, because of technology advances, can offer attractive tariffs, especially for higher volume users. Using current satellite technology, ground stations tend to be somewhat expensive and are most often supplied by the satellite carrier on a shared basis. This tends to limit their role in the local access area.

On the other hand, satellites can substantially reduce the cost of backbone communications, given sufficient data requirements.

In particular, the cost of high data-rate satellite channels is substantially lower than their terrestrial equivalents. As higher frequency satellites develop, smaller and cheaper ground stations will become feasible and consequently a greater number of such stations will be economically feasible. Within the next decade, satellites may be able to serve most of the medium- and large-size locations of a large organization.

However, unless major breakthroughs in transmission technology are forthcoming, there may not be sufficient capacity available within currently feasible frequency bands to serve the array of desirable services. By the mid-1990s, major transmission advantages could return to terrestrial systems via optical-fiber transmission, a technology that is now rapidly moving from the proof of feasibility to the operational stage.

Local Communications

The impact of local access is most obvious when one travels between New York and Washington, D.C., spends an hour in an airplane and two hours in taxis going to and from the airport. A similar phenomenon is felt when one attempts to transmit a message electronically between these points. However, in this case, instead of travel time being disproportionate to distance, cost is the disproportionate factor.

Local communications requirements can be divided into several levels which include:

- Communications between devices (telephones, terminals or computers) in a single building.
- Communications between devices located in different buildings in a campus-like environment.
- Communications between devices distributed over a small geographic area such as a city.
- Communications from a device to a traffic-gathering point of a long-haul transmission system.

During the 1980s, intrafacility networks will evolve for connection to the transmission plant of a transmission supplier (such as a local phone or community antenna television company) for intersite communications. Figure 1 illustrates the conceptual arrangement of such a local system.

From the engineering point of view, the intrafacility designer has a wide choice of proven technology and read-

"Intrafacility networking schemes are now under development. After 1985, they will be considered quite routine."

ily available new technological breakthroughs. These include transmission medium alternatives (such as twisted pair, CATV and optical fibers), interface capabilities offered by the high-speed, microprocessor-based hardware and protocol advancements, both at the conceptual level and via the development of specialized large-scale integration (LSI) chips. Local intrafacility networking represents a new type of environment where bandwidth (speed) is not the main constraint and tariff optimization is not an issue.

Future systems of the 1980s will offer a local network structure capable of providing compatible interconnection of numerous and various terminals, data processing and storage devices, word processor communications, electronic document distribution, teleconferencing, transmission of monitoring, control and safety-related signals, video and closed-circuit TV communications and so on.

Gateways will connect available or proposed long-haul networks, such as the common carriers and the value-added systems, to the local distribution intrafacility systems. Several intrafacility network schemes are now under development. These will begin to find widespread acceptance in the 1983-1985 period. After about 1985, the concept of intrafacility networking will be considered quite routine.

Two different approaches have been taken by the local network vendor community:

(1) *Baseband data networks* operating at speeds of 1M- to 10M bit/sec. As the major example of this type of system, we cite the Xerox Corp. Ethernet, initially supporting the Xerox-860 word processors and several other Xerox products. The long-range goal of Xerox, along with DEC and Intel Corp., who are cooperating on the development of Ethernet technology, is to have Ethernet become the standard intrafacility network architecture.

(2) *Broadband RF cable networks* providing frequency division multiplexed (FDM) channels for control, monitoring and safety applications, including voice and 1M- to 10M bit/sec video dedicated channels. A standard CATV two-way tree architecture is used to provide such "integrated" services. As an example, we cite the Network Resources Corp. Macrosat.

Choosing the Medium

The choice for an intrafacility transmission medium involves one of three basic technologies: coaxial cable (either using an RF carrier, as in CATV or baseband signaling); twisted pair; or optical fiber. The criteria of selection include bandwidth (speed) requirements, expansion capabilities, cost, availability of standard off-the-shelf components, reliability, medium passiveness, ease of branching, error rate and noise immunity and transmission integrity.

CATV technology represents an attractive alternative, which provides ample bandwidth using reliable, proven and cost-effective equipment. The coaxial two-cable system, operating on 54- to 300-MHz radio frequencies, can accommodate 41 channels of 6 MHz, each carrying 5M- to 10M bit/sec of data depending on modulation and frequency guard bands. The total capacity for data transmission is, therefore, between 200M- and 400M bit/sec, surpassing most current anticipated needs by a large margin.

Furthermore, data transmission using commercial CATV technology has been shown to provide excellent transmission quality (bit error rate better than 10^{-6}) and cost-effectiveness for local distribution.

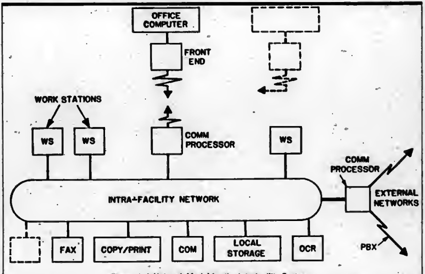

Figure 1: A Network Model for the Intrafacility System

Fiber optics, on the other hand, which is a very attractive technology in terms of noise and interception immunity and channel capacity, is not yet suitable for a commonly shared multiple-access architecture. In the current state of fiber optical technology, fibers are used mainly for point-to-point communications, since any branching is still cumbersome, expensive and not reliable.

Baseband transmission provides a reliable passive medium at distances up to one mile. It is, however, limited to a single channel transmission, usually within 1M- to 10M bit/sec. In an integrated environment with broadband transmission requirements such as voice and video, RF transmissioo is mandatory.

Two types of CATV configurations have been proposed for transmission in a local area communications network. One uses a single coax cable with the forward and return traffic multiplexed in frequency such that the lower half-band (5- to 110 MHz) is used for the return channels and the upper-band (160 to 265 MHz) for the forward channels.

The second approach, developed by the Mitre Corp., uses two parallel cables, one for the outbound and one for the inbound traffic. A head-end repeater is used to feed the inbound cable. One-way amplifiers are used on each cable. Given that the cable cost does not represent an essential factor to the network design, the two-cable configuration appears more advantageous. It provides twice the network capacity and does not introduce two-way active components, which reduce overall reliability and availability and introduce potential crosstalk interference.

Communications between points in different buildings with separations from a few thousand feet to several thousand miles can be accommodated by several alternatives. Today, virtually all local communications are implemented through the conventional offerings of the local telephone companies. However, cable television systems are beginning to play a role; interfacility communications and radio-based techniques have been tested and shown viable.

Of the newly developed local-access approaches, CATV is the most mature. CATV systems provide a usable medium for data transmission which, during the last decade, was shown to have low error rate without interfering with video transmission. Since the systems are intended primarily for the transmission of entertainment video, their characteristics were not designed for data transmission. However, with signal-to-noise ratios of better than 40 dB and bandwidths, in an unused TV channel of 6 MHz, they would seem to be ideal for data transmission.

Furthermore, once systems are built for TV transmission, data can be piggybacked at marginal costs. The major incremental cost for adding data to a conventional two-way CATV system is the cost of the interface device — the bus interface unit. Such devices are now becoming available and over the next several years their prices will make the technology competitive with conventional telephone company offerings.

During the last decade, a sequence of experimental systems were built to allow many users to share the resources of single broadband channels. For example, the Aloha System was built at the University of Hawaii as an experiment in radio communications via packet switching. It consisted of standard data terminals with radio front ends communicating with a central station connected into a satellite ground station and also into Arpanet. Aloha forms the basis of a new technology being applied to both terrestrial and satellite radio data communications: random-access multiplexing.

In a random-access multiplexing scheme, the medium itself is the multiplexer. In its most straightforward implementation, random access is analogous to the situation where several people participating in a telephone conference call speak simultaneously. When conflicts occur, a natural protocol causes a subset of these people to retransmit at a later time. This scheme is similar to that which occurs when several terminals are connected to the same port of a front end or computer without using a multidrop polling discipline. If simultaneous transmissions occur, all will be distorted, and retransmissions will be required.

Random-access techniques are currently being studied for both extensive ground and satellite broadcast systems. One experiment now under way is investigating random-access transmission on satellites connecting users in the U.S. and Europe. This experiment is evaluating the validity and efficiency of a variety of different access and retransmission schemes and may provide a major input for new satellite and ground station developments.

Another system currently under test by Arpa utilizes random-access transmission for mobile ground terminals.

"The integrated network of the future is technically feasible now; many of its components exist as off-the-shelf devices."

Called the Packet Radio System, it is aimed at providing efficient local access for mobile terminals, terminals in remote or hostile locations where cables are not feasible, terminals with high ratios of peak-to-average bandwidth requirements and terminals which require small bandwidth so that hardwired connections are uneconomical. Commercial equivalents of this system are being developed by Xerox for the Xerox Telecommunications Network (Xten] system and by a newly formed corporation, "LDD," as a joint venture of Aetna Life and Casualty and M/A COM.

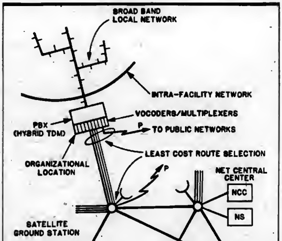

Figure 2: The 1990 Integrated Network

The packet radio (PR) technology was primarily developed to address communications requirements of applications for which the present conventional technology is not particularly suitable and to provide more efficient techniques for frequency spectrum utilization. The PR technology is particularly suitable for applications in which:

- Resources (such as terminals and computers] are mobile, so that a broadcast mode is necessary.
- Resources are located in remote or hostile locations where hardwire connections are uneconomical or not feasible.
- The traffic characteristics are of a bursty nature; that is, there is a high ratio of peak bandwidth to average bandwidth requirements.

The hardware of the PR technology is based on the packet radio unit (PRU], which consists of a microprocessor with associated electronics and a radio transceiver. The applications software of the technology consists of a set of novel techniques for dynamic sharing of the communications channels, for efficient and reliable packet transportation, for network initialization and reconfiguration and for real-time diagnosis and control of programs and parameters in the PRUs.

There are three basic functional components of the packet radio system: the packet radio terminal, the packet radio station and the packet radio repeater. The PR *terminal* consists of a common type of terminal or computer interfacing to a PRU. The *repeater* is a stand-alone PRU which operates as a relay switching node and provides radio connectivity to interconnect communications devices within the radio net and/or to connect to a gateway into another network.

The PR *station* consists of a minicomputer interfacing to a PRU. The station performs such functions as PRU initialization, connectivity monitoring, global stability control functions, accounting, buffering and directory functions for radio communications devices. When the PRNet interfaces with other networks, the station performs the gateway functions.

A Look at Cost

The primary cost element of such a system is the cost of the packet radio itself. Indications are that these units will be available for less than $5,000 each by 1985. Network Analysis Corp. (NAC] studies have shown that with packet radio unit costs in this range, packet radio systems can provide a viable and cost-effective communications technique for local distribution in conventional urban or suburban environments.

Technology now emerging will allow many organizations to implement integrated systems that carry many types of traffic. For a large organization, there are significant advantages in integrating its voice, message, data and facsimile requirements:

- Voice circuits currently not utilized after business hours will be available for data, message and facsimile traffic during off-hours.
- If separate requirements for voice, message and data are combined, the total number of circuits needed can be reduced without degrading service quality.
- The individual requirements of voice, message and data at a given site may not justify a leased circuit, but the combined requirements might, thus introducing economies of scale.
- An integrated network will facilitate the use of new digital communication transmission service offerings as these become generally available.
- An integrated network will support integrated functions which combine, in a single exchange, mixed modes involving voice, data, facsimile and video.

Because of the radical reduction in cost of digital logic, it is now relatively inexpensive to convert voice and facsimile to digital signals and to perform sophisticated digital switching. In addition, digital transmission has more resistance to noise than analog transmission, and switching, compression, encryption and other "added-value" services can be more easily implemented digitally. The result of these factors is a strong motivation for combining all modes of communication onto digital channels.

Sophisticated digital switches are being developed which will be able to switch voice, data, message and facsimile traffic in any combination. By 1985, most suppliers of conventional private telephone branch exchanges (PBX) will be offering PBX devices with these features. While the specific characteristics of future networks containing these switches are not yet definitized, a pattern has emerged which allows us to predict the architecture of the future integrated network. This architecture is illustrated in Figure 2.

The future integrated network will have a primary digital backbone connecting a set of either public (owned by a carrier] or private (owned by the user) switching nodes. Initially, these switching nodes will be based on circuit switching technology. In many cases, packet switches will then be attached as users of the circuit-switched system. They will be replaced later by hybrid switches combining the best elements of circuit-switching and packet-switching technologies. Ultimately, the switches may become pure packet switches serving both voice and data. However, such switches will be utilized in only special cases until the latter half of this decade.

The switching nodes will be connected together via common carrier digital lines, either terrestrial or satellite. If satellite, there may be additional transmission facilities from the site of the switch to the satellite ground station.

Connected to the switching nodes will be local-access trunk lines emanating from computerized PBXs located on customer premises. For a long time, many trunks will remain analog if routed on terrestrial facilities. Eventually, some of the links between the PBX and switch might become radio channels, but this migration will depend on the cost of radios, ground stations and the tariffs for terrestrial circuits. It is highly likely that as communications hardware continues its cost decline with respect to the cost of transmission, more and more local access will be accomplished via radio techniques.

Technological innovation during the last decade has focused on the long-haul backbone networks for which equipment manufacturers and carriers have provided numerous cost-effective options. Future efforts, however, will center on the local-access area, with the PBX as the focus of attention. The future PBX will be the interface between growing intrafacility networks and the outside world. In addition to its most advanced current features and elements, it will contain banks of voice digitizers and dynamic multiplexers and will also be able to interface directly to remote PBXs, packet switches and a variety of other network controllers.

The integrated network of the future is technically feasible now, and many of its necessary components exist as off-the-shelf devices. Within the next five years, the costs of these components will have become low enough to allow large organizations to begin cost-effective implementation. Since the need to transmit combinations of voice, data, message and facsimile traffic is characteristic of the modern organization, strategic planning for these networks will become a major area of attention within the next few years. None of the existing network implementations are fully suited for use within integrated networks, and substantial efforts will be needed to incorporate the emerging requirements for electronic mail, voice storage systems, facsimile and what has come to be called the "office of the future."

This evolution will place demands on the organization in terms of the way it manages and controls its networks. Today's organization typically maintains separate departments for voice and data communications. The latter is usually part of the data processing operation. As the technological means to integrate various modes of communications develop, the management of these modes will merge. This process is beginning now and will span the decade. More than any other factor, the development of human resources (both technical and managerial) is likely to determine the speed with which the promise of the technology is achieved. While the challenges are great, the potential benefits of the new technology make the effort critical to our information society. ◆

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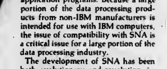
By Saroj K. Kar

CLOSING THE GAP: COMPATIBILITY WITH SNA

IBM since 1975 has been promoting its Systems Network Architecture (SNA) as the infrastructure for all future IBM data processing and data communications products. A significant number of IBM users, especially major ones, have already migrated to SNA or are in the process of doing so. Even small and medium-sized IBM users now accept that they have to migrate to SNA. An essential question is no longer, "Should we?" but "When?"

Assuming SNA to be inevitable for the vast majority of IBM users, the issue of compatibility with SNA, that is, being able to use non-IBM products, is one of critical significance for a large number of IBM shops. The compatible products include: terminals of all shapes, sizes and intelligence; modems; front-end processors (FEP), or communication controllers; plug-compatible mainframes (PCM); and application programs. Because a large portion of the data processing products from non-IBM manufacturers is intended for use with IBM computers, the issue of compatibility with SNA is a critical issue for a large portion of the data processing industry.



The development of SNA has been both evolutionary and revolutionary. During the latter part of the 1960s, it became obvious that data processing during the 1970s and beyond would be closely integrated with data communications and that its efficiency would depend heavily upon the efficiency of the data communications system.

Evolution of data communications as used in data processing had been haphazard and, essentially, need-driven. Two basic protocols (data link control) have dominated the scenario: (1) start-stop for slow, usually human-operated interactive types of terminals, and (2) binary synchronous communications (BSC) for higher speed buffered types of devices.

Even within IBM, various products used different flavors of BSC and start-stop protocols, requiring different types of hardware (line adapters) in the communications controller, and different software modules in the host CPU.

Supporting such a wide variety of hardware-software combinations had been a nightmare not only for users but also for IBM. IBM realized that, to meet the close coordination between the data processing and data communications functions necessary for the products of the late '70s and '80s, a revolutionary approach or architecture had to be developed. High-powered research activities began within IBM, and, after several trials and errors, the basic architecture and principles were agreed upon in the early '70s. This architecture became SNA.

IBM decided SNA would be the technical and marketing infrastructure, that is, the base for all future data processing and data communication products. All IBM components (mainframes, terminals and application programs) would use this structure for communications (see Figure 1). IBM's commitment to SNA rivals its commitment to the 360 series.

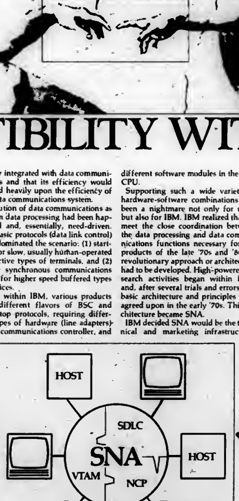
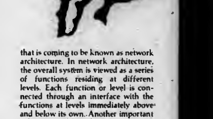


FIGURE 1: SNA: BASE FOR IBM'S DATA PROCESSING PRODUCTS FOR THE 1980s

A major feature of SNA is the use of a common communications network using Synchronous Data Link Control (SDLC). The first major item in SNA to be announced it is also the most publicized. SDLC is full-duplex and it is possible to attach different types of devices (interactive and RJE) on the same multidrop SDLC link. However, SDLC is only one component of the data link control part of the total SNA system, although even now, many users and some manufacturers make the common but deadly mistake of considering SDLC and SNA synonymous.

SNA is based upon the technique that is coming to be known as network architecture. In network architecture, the overall system is viewed as a series of functions residing at different levels. Each function or level is connected through an interface with the functions at levels immediately above and below its own. Another important rule in network architecture is that a level is allowed to operate (that is, handshake and exchange relevant in-



Saroj K. Kar is president of Telecom Computer Technology International, Inc., Sunnyvale, Calif.

> **"Compatibility with IBM teleprocessing systems used to mean emulation of the DLC. Now it means compatibility with all six layers."**

formation) with its "peer-level" function only.

Extensive activities are going on at the International Standards Organization (ISO) on a seven-level network architecture model commonly known as the Open System Interconnection (OSI) model. Substantial similarity exists between the proposed OSI model and IBM's SNA.

SNA Levels

SNA has six levels: end user, presentation services, transmission control, path control, data link control and physical control.

The basic functions of the SNA layers are as follows: end users are the source and destination of the SNA messages. These messages may be data or control types. The end user may be a device, a person or an application program or subsystem, such as IMS. The end user is not considered an integral part of the SNA architecture, but rather the user of the architecture.

Presentation services, the second layer, provide the necessary facilities and rules for the end user to use the communication network. The logical unit (LU) component of SNA provides the presentation services.

The third layer, transmission control (TC), provides the acknowledgment protocol to be used between the two communicating entities, soch as the types of acknowledgement, resolution of contentions, error recovery procedures and so on. This layer also controls the flow of data between the two communicating members.

The path control (PC) function, layer four, is responsible for routing the messages between the two communicating members. It contains all the necessary facilities and resources required for path determination and switching within each node in the SNA network. PC also contains necessary segmenting facilities, should it be necessary.

Layer five, the data link control (DLC) function, is responsible for providing an efficient linkage between the two communicating path controls. The path control function hands over the message to the DLC, which has the responsibility of transmitting the message to the desired DLC at the remote end and taking necessary actions in the event of any bit errors. SDLC provides the DLC function in SNA. The CPU channel is also a valid link for SNA for attaching the local devices directly to the host CPU.

The physical control function, layer six, is essentially the modem interface, an RS-232 or the equivalent. Its function is to provide the physical and logical intsrconnection between the data terminal equipment (DTE) and the data communications equipment (DCE).

These functions communicate with their adjacent levels through internal interface and with their peer-level functions through headers. For example, as a message travels from the end-user level to the physical control level, headers (and also trailers, when necessary) are generated by each level as the message passes through it. These headers are concatenated as overhead to the data portion of the message.

The principal items providing the functions, layers and the infrastructure in SNA are: Virtual Telecommunications Access Method (Vtam) in the host CPU, Network Control Program (NCP) in the communications controller (3705), SDLC and Cluster Controller Node (CCN). Together they form the basic communications infrastructure. The NCP may be both local and remote.

A large number of IBM users, especially the major ones, have traditionally used a variety of compatible non-IBM products to operats with their IBM host system, that is, with IBM mainframe and primarily IBM host software. The compatible products include terminals with different degrees of intelligence, modems, telephone networks (mainly from the Bell system), front-end processors, host software and even PCMs. The following are the main reasons for their use of non-IBM products:

- **Price.** In most cases, the compatible product has cost between 10% and 20% less than the comparable product.
- **Performance.** In general, the compatible products offered better performance than the IBM product.
- **Features/functions.** Independents offered features and functions that were more attractive for the customer's applications and were also willing to adjust the product to suit the customer's specific needs, especially for major customers.
- **Better customization support.** Independents customize a product for the specific application, especially for major users. It has been extremely difficult to get similar service from IBM.
- **Better flexibility.** To operate the product with other product devices; independents, especially smaller companies, have been very cooperative in the use of their prodocts with devices from other companies.
- **Better service.** This is a location-dependent factor. However, in most major cities, the independent services have matched that of IBM quits favorably.
- **Better delivery time.** Better buy/-lease agreements.
- **Easier upgradability.** Often without having to change the basic equipment.
- **Software cost.** IBM software is available on lease only: whereas independents' software is, in geoeral, available for both lease and buy options.
- **Many users,** especially major ones, do not want a total one-vendor system.

Compatibility Problems

Until the late 1970s, compatibility with IBM's teleprocessing systems could be achieved by emulating the data link control procedures, specifically binary, BSC, or start-stop. Most IBM devices used a slightly different flavor of BSC and start-stop protocol. However, the protocol itself became fairly well understood and was comparatively simple to emulate.

Emulation meant providing similar types of functions in the terminal to those offered by the IBM device and the DLC (with specific flavor). During the 1970s, a large number of very successful IBM-compatible teleprocessing products emerged.

In SNA architecture, the DLC is just one layer. To be compatible, the device must be compatible with all the six layers. Compatibility includes being able to process all the different types of headers used in the SNA message formats. The SNA message header comprises four distinct fields.

- The outermost header (LH) is the link header and link trailers used by the data link control, which is SDLC for SNA.
- The transmission header (TH) field contains routing information such as destination address, origin address and the message identity. The (TH) field is used by the switching nodes during the travel of the message from origin to destination.
- The request/response header (RH) field contains end-to-end handshaking and acknowledgement protocols to be observed by the two communicating entities.
- The request/response unit, (RU) field, is the information/data part of the message. It contains information for use by the destination end user. For certain types of messages, RU contains information describing the types of information contained in the message.

The LH field is required by SDLC. TH and RH field formats are common to all types of field formats.

The content of RU is the most complex portion of the SNA message. It contains information regarding the motually agreed protocol between the two end users, to be observed for the data term's first session. It is called Bind session, the mutual agreement between the two end users regarding handshaking protocols to be used during the data transfer session. The exact RU format is device-dependent. The device has certain unique or special formats and protocols used for transferring data and controlling its special types of devices.

The relationship between the end user and the SNA component is handled by the logical unit (LU). The LU essentially provides facilities for the end users to access the network.

SNA compatibility requires that the device or system be compatible with all the header fields, interaction protocols and, most importantly, with the Bind parametsrs (agreement for data exchange between the two end users).

Compatibility Levels

Here are the network components in SNA:

- Physical units (PU), essentially the logical nodes.
- Logical units (LU), the facilities for the end users to access the network.
- Data Link Control (DLC), which may be SDLC or CPU channel in SNA.

Compatibility may be achieved at different PU levels. There are, at present, four types of PUs in SNA.

- **PU Type 1** is the terminal node (TN). This is the simplest type, essentially using simple devices such as CRT keyboard (3270) or printer keyboard (3767). The basic intent of PU Type 1 is to provide a BSC/SS type of device for the end users for easy migration to SNA. Most of PU Type 1 devices may be operated in both BSC start-stop or SDLC mode.
- **PU Type 2** is the Cluster Control Node (CCN). This is the principal type of device used in SNA. PU Type 2 comprises a full-fledged node supporting a number of LUs, into which the "end users" are attached. The end users could be devices such as CRT terminals, keyboards or application programs. Most of the newer and advanced IBM devices use PU Type 2 or CCN nodes.
- **PU Type 4** is the communications controller. Currently in SNA this is the combination of the 3705 Communication Control Unit and NCP. PU Type 4s perform as major switching nodes in the SNA network.
- **PU Type 5** is the host node, essentially the mainframe or host CPU. PU 5 contains Vtam and application programs using Vtam. The overall network manager, system service control point (SSCP), is a module in Vtam. SSCP is responsible for the control, management and coordination of all the cumponents within the network.

Compatibility may be achieved at any of these levels, that is PU1, PU2, PU4, PU5.

A major factor in SNA compatibility is the application programs, especially for IBM-supplied application subsystems such as IMS and CICS. The LU equivalent in the compatible product (normally a program in the compatible CCN) must be able to operate with the application program in the host. It must have the same SNA macro operands options, data formal and hand-shaking protocols as the IBM-supplied application program in the host. In addition, it must also comply with the recovery procedure used by the IBM application program in the host CPU.

Control and Management

Since IBM's announcement of the single host operation of SNA in 1975, SNA has come a long way. In fact, Network Control and Management Facility is one of the major attractions of SNA for the users. Following are some of the highlights of the current version of SNA (SNA Release 3):

- **Multihost operation.** Current SNA can support a large number of hosts in a complex network.
- **SNA domain.** Essentially the group of nodes and LUs is controlled by a single system service control point (SSCP): the network manager. SSCP is a component in Vtam. Vtam is a host-resident Telecommunications Access Method (TAM) program. Essentially the domain is built around the TAM which in SNA is a Vtam or ACF/-Tcam. If a host CPU contains two access methods, then two domains will be controlled from the same host CPU. A domain consists of several subareas. Subareas are resources controlled by the access method or the NCP. The link between domains is via NCPs.
- **Address structure in SNA.** The usual SNA network address is 16 bits long comprised of two fields — subarea and the NAU address. NAU is the Network Addressable Unit, an SNA entity with an address (such as LU and SSCP). The combination of subarea

"IBM is committed to SNA as a product base for this decade. Support for pre-SNA hardware and software is gradually being dropped."

and NAU address is unique for each addressable unit in SNA.

In the current TH, the 16-bit network address can support up to 16,000 addressable units in the total network, a large number. Multihost operation allows many hosts to communicate with each other with a network of nodes and links.

In most systems 8 bits are used for subarea address and 8 bits for NAUs within that subarea. This allows a subarea to contain up to 256 addressable items (mostly LUs — end users).

- **Multiple ports.** The current version of SNA allows multiple links to exist between adjacent NCPs for better reliability and higher throughput.
- **Explicit route selection.** This feature of SNA 3 enables the originating end user to specify the exact route (chain of nodes) a message should travel through to arrive at the destination end user.
- **Improved recovery mechanism.** In the event of a host breakdown, the NCPs in the domain are kept operational by a predesignated host. The sessions (logical connections) passing through the NCP are continued except those with the effected host. Normal operation is resumed when the host returns.
- **Network problem determination aid (NPDA).** An IBM-supplied diagnostic program in the host to determine problems in any part of the network and take necessary recovery actions. NPDA is also a major attraction for the users for control and maintenance of a major SNA network.

Compatibility Level

Determination of where and how to be compatible with SNA — at which level to communicate with an SNA network — is complex. Following are the factors in this consideration:

- **Device to emulate.** The IBM device the manufacturer wants to be compatible with may be a CCN, NCP or even a host. The nature and function of the device essentially determine the level of compatibility. The most common compatibility level is CCN (PU Type 2).

However, the exact set of SNA commands and responses, especially the Bind parameters, are somewhat different for different types of devices. For example, the set for 3276 (CRT display system) and 3776 (RJE system) are not the same.

- **Functions and message format.** The exact message format and functions for the particular CCN type must be carefully analyzed. The compatible device must be able to process those.
- **Data flow control.** This is different for different device types and for any particular device must be fully understood and emulated..
- **Data link control.** This is SDLC for remote devices and CPU channel for local devices. This is the easiest part of compatibility.
- **Addressing structure.** Exact address structure for the device must be emulated.
- **Network operation and control.** This includes the various route parts and link selection as supported by the IBM device.
- **Network management.** Must comply with the network control commands and functions as performed by the emulated IBM system. This is especially true when emulating an SNA host or FEP.
- **CCITT - X.25 interface.** Currently IBM is offering the X.25 interface as an RPQ in Canada and France. It is expected to be offered as a standard product in other parts of the world including the U.S. The X.25 is expected to be a most common interface for using Public Data Network (PDN) to operate with SNA. The exact type of interface and its detailed characteristics must be understood.
- **Diagnostics** as used by the emulated IBM device. This is a crucial item and must be given thorough consideration. As stated earlier, the network diagnostic tools, such as NPDA, are a major attraction of SNA for the users.

IBM Commitment

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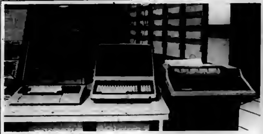

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Atlanta·82

By Francis X. Dzubeck

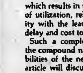
NETWORK MANAGEMENT:

PUTTING THE PIECES TOGETHER

Successful network management can be succinctly described as the complete, organized control of the motion of data through a network which results in the highest percentage of utilization, reliability and availability with the least amount of internal delay and cost to the user.

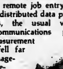
Such a complex sentence indicates the compound nature of the responsibilities of the network manager. This article will discuss those responsibilities and present the means by which the network manager can, using present technology, create a manageable entity.

The task of network management, from the small centrally controlled network to the distributed, multitiered network, can be divided into four distinct areas of responsibility and control: Performance, availability, operations and R&D and cost.

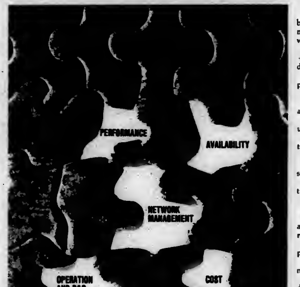


Network performance measurement is management's most effective tool in monitoring the usage and growth pains of a network.

The computer vendor, from the first days of communications integration into DP, has always provided some form of data gathering capability and utilization report generation as part of his communications executive. As the users progressed to multiple-tiered and multiple-vendor networks containing clustered terminals, concentrators, multiplexers, remote job entry (RJE) systems and distributed data processing systems, the usual vendor-supplied communications performance measurement procedures fell far behind management requirements.



In fact, it was not until June 1979, with IBM's announcement of Systems Network Architecture (SNA) Release 4, that a computer vendor fully ventured into the area of communications network management. Although SNA still requires all IBM components in order to operate effectively, the basic elements exist for an integrated performance monitoring system.



The other computer manufacturers have not yet followed IBM's lead, thereby permitting the entry into the marketplace of various small systems integrators of communications performance measurement tools (stand-alone, specially programmed minicomputers connected through the network to each user node). This solution, often protocol dependent, still does not allow the manager to be totally flexible in his choice of vendors or network configuration.

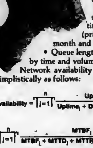
The management, in reality, should attempt to create measurement tools relative to its specific network and the equipment at each end point. Thus, management should integrate the best of computer manufacturer-supplied tools, other vendor performance aids, and its own ingenuity via software to create a comprehensive performance measurement and evaluation system. This integrated approach is an absolute necessity for effective management.

Management for the first time will have at its disposal within this environment the ability to distribute software to do the data gathering for true and accurate performance measurement. Information should be gathered from the various hosts, end points, and the intranetwork nodes (gateways, concentrators and so on) every hour, with instantaneous peak readings taken on a demand or exception basis. This information can be used as a real-time summary of network performance and for detailed daily reports. The following report content should be available to management as a minimum requirement for distributed network performance evaluation:

- Cumulative network downtime.
- Detailed subnetwork downtime.
- Circuit utilization reports.
- Response-time analysis.
- RJE vs. interactive usage.
- Narrative vs. data usage.
- Queue length descriptions.
- Histogram of daily usage.
- Failure rate of subnetwork by time slot.
- Local CPU and file activity statistics.
- Local device error activity.
- Network gateway failure statistics.

The following statistical reports will also be required by management for network trend and growth analysis:

- Distribution of character and packet volume.
- Statistical profile of all time-related network traffic.
- Distribution of traffic by time of day and location.
- Peak volume statistics.
- Correlation of activity related to a similar time period (prior day, month and so on).
- Queue length statistics by time and volume.



Network availability is defined simplistically as follows:

$$\text{Availability} = \prod_{j=1}^{n} \frac{\text{Uptime}_j}{\text{Uptime}_j + \text{Downtime}_j} =$$

$$\prod_{j=1}^{n} \frac{\text{MTBF}_j}{\text{MTBF}_j + \text{MTTD}_j + \text{MTTR}_{1j} + \text{MTTR}_{2j}}$$

Where: MTBF = Mean Time Between Failure
MTTD = Mean Time to Diagnose
MTTR_1 = Mean Time to Respond
MTTR_2 = Mean Time to Repair
n = Total Number of Network Elements

Until recently, this key element of network management has been within the user hands-off area of common carrier responsibility. With the continued installation of customer-provided interface equipment, the user became able to locally "assist" the telephone

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> "The concept of the network control system is applicable throughout the data communications spectrum — it applies to both the small and large user."

company in the diagnosis of faulty equipment or circuit facilities. Even today, where digital communications services are common-carrier provided or the user takes advantage of a value added/public carrier, the responsibility for network availability remains in the hands of the vendor. That is to say, the manager may be offered a high MTBF, but his ability to reduce MTTD, $MTTR_1$, and $MTTR_2$ is nonexistent.

This leads us to the always present world of analog circuits and modems. This important segment of the network facility will be with us until the next century in remote areas of major cities and rural locations.

Today's analog user can have a high degree of influence upon the values placed into the network availability equation. The MTBF of the vendor-supplied network interface equipment can be influenced by selections based upon the criterion of high reliability, that is, greater than 30,000 hours. The MTTD is directly related to the ability of the user to isolate and diagnose failure by component-line, network end-point equipment or modem. The $MTTR_1$ and $MTTR_2$ can now be controlled by the user through use of selective redundant interface equipment and alternate circuit paths.

Response and repair can effectively be almost instantaneous with the use of controlled on-line switching systems. The user has a major area of concern with respect to circuit MTBF. This sacrosanct responsibility of the common carrier must be viewed pragmatically as a management "hope for the best" situation. The following items, which are beyond the control of the manager, may dictate circuit MTBF: physical location of circuit end-point, circuit engineering, central office bridging, age of plant facilities, local loop quality and the lack of qualified common-carrier test facility personnel.

Three Levels of Control

The management control tool required to achieve a high percentage of network availability is the network control system. The system contains three levels or degrees of control (see Figure 1 on Page 96):

1. **Functional level.** This is the network architecture level usually supplied by the computer manufacturer where the network takes shape as a configuration with priorities, restrictions and routing groups. At this level, all component alarms and protocol errors are analyzed and displayed to the network controller. The controller can take action by command logic to stop, start or software-test a network end point, associated peripheral devices, concentrators or other intelligent network elements. If the diagnosis by the controller shows a fault, the controller may reroute the traffic or reconfigure the network to bypass the problem.

2. **Interface level.** This is the control level which monitors and diagnoses failure of the modems, multiplexers and gateways within the network. Until IBM's entry into the modem marketplace (SNA Release 4) and the announcement of Dataphone II by AT&T, this area of control belonged to the independent modem vendors. The command system structure is similar for all vendors, with the capability (through in-band/out-of-band signaling) to monitor the RS-232C interface or strap option settings, scan for error faults and allow the network controller to test the components and remotely implement diagnostic modes — screaming search, audio loopback and end-to-end and bit error tests.

As a result of the above testing, the controller can command the modem to disconnect, switch to dial backup or a hot standby and change the strapping options or fallback rates of the modem. In addition, this level is also the early warning point for circuit error and failure detection.

3. **Circuit level.** This is the control level which allows the monitoring and diagnosis of analog voice-grade common-carrier supplied circuits. Using the interface control level to isolate a network test point, the circuit quality is monitored to produce actual signal levels and a measurement of the variation from a preset quality standard for frequency shift, noise, phase jitter, harmonic distortion and so forth. Also at this level, history and predictive trend analyses are performed as circuit failure early warning aids. The capability of detailed circuit quality monitoring is new for network controllers, because it has always been the responsibility of the common carrier to diagnose and trouble-shoot its own problems. The long outages and excessive mean time to diagnose, respond and repair by the common carriers have made this level an important part of the network control system.

The concept of the network control system is applicable throughout the data communications user spectrum. The small user (see Figure 2 on Page 96) has at his disposal new, inexpen-

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"Network control for the large user begins with the implementation of some form of hierarchical network architectural software."

sive monitors and test equipment which he can utilize in a manual mode for local analysis. The following forms of test equipment would be required in a small user environment:

- Breakout monitor.
- Bit error rate tester.
- Manual patchfield.
- On-line data content monitor.
- Frequency/level/noise meters.
- Local modem and end-point diagnostic tests. This small inventory of test equipment applicable to the interface and circuit levels of the network control system, coupled with the computer vendor supplied functional level reports, can provide a high percentage of network availability to the small user.

Large-User Needs

The larger user (see Figure 3 on Page 96) operating a remote distributed data processing network requires an automated/integrated, yet centralized, network control system. Centralization allows the user the ability to manage a broad class of failures without duplication of equipment and personnel. The concept of centralization of network control will be discussed further as it relates to the cost of network management.

Network control for the large user begins with the implementation of some form of hierarchical network architectural software. This may be vendor supplied (SNA, Decnet and so on) or user created. Included in this level is the man/machine interface in the form of a stand-alone network control processor or integrated I/O devices with associated software resident in one of the host computers in the network.

After the main functional network control level is established, the user can select from one of the various vendors (Codex Corp., Milgo Electronic Corp. and so on) a suitable interface control level. Unfortunately, at this point we find each modem vendor implementing a different control system linked to his particular modem. The marketing philosophy is obvious, but the practicality of a single-vendor network to the user may not exist.

The large user's only alternatives become multiple interface control systems to diagnose and control each different vendor's modem within the network; a user-programmed minicomputer network management system interconnecting multiple vendors' unique minicomputer network controllers; or the implementation of a microprocessor analog/digital control unit ("wraparound" device) at each end point. Only the last two alternatives offer a vendor-independent interface level.

The large user finally is concerned with the circuit control level in the form of circuit quality monitoring and the ability to remotely perform switching to a redundant component or alternate circuit path. This capability is just beginning to be provided by the modem vendors, utilizing their previously mentioned interface control systems along with distributed microcomputers to examine the equalizers in each modem. This technique, although not 100% accurate, offers the user a tremendous diagnostic aid.

Operations and R&D

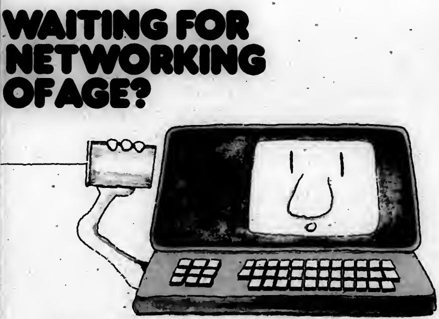
Network management must also control the day-to-day activities of the operation of the network. There are three areas to be given operational consideration:

1. **Documentation** of the network is a requirement for centralized network control and performance measurement of the system. The documentation should, as a minimum, be as follows:

- Circuit layout record.
- Network map.
- Hardware/software cross-references.
- All network vendor maintenance records.
- Software listings by network task and component.
- All user-site telephone numbers and individual contacts.
- An interface component maintenance history log located at each user or nodal site.
- Circuit control telephone contact index and log.
- Maintenance history by component.
- Inventory by serial number of all network components by site.
- Network redundancy locations and switching criteria.
- Vendor contractual or tariff commitments.

2. **Procedures** for network management should be well defined by the user for effective personnel direction and operations control. An example of such procedures is as follows:

- Operations manuals by network component.
- Comprehensive view of network operation.
- Trouble tickets.
- Escalation levels.
- Preventive maintenance guidelines.



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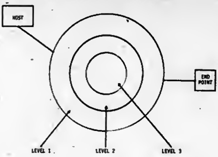
> **"The network manager should reevaluate his topology every five years, with a major restructuring, if required, every two years."**

- Fallback techniques.
- Diagnostic techniques by component or type of trouble.
- Disaster protection or recovery manual.

3. **Personnel** practices are management's weakest link within the network operational environment. The ability to hire qualified personnel may well be outside network management's realm of responsibility. If so, the requirement exists to define for the corporate personnel office the prerequisites for each operational position and the "intrinsic qualifications" that make a candidate suitable for hire.

After selection of a suitable individual, the network manager must establish a training program which will accomplish the "bringing up to speed" of the new hire and present the individual with all applicable network documentation and procedures.

NETWORK CONTROL LEVELS



LEVEL	TYPE
1	Functional control utilizing a network architecture
2	Interface control utilizing in-band/out-of-band signaling
3	Circuit control utilizing circuit quality monitor

Figure 1

SMALL USER NETWORK

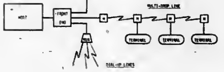


Figure 2

LARGE USER NETWORK

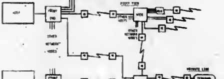


Figure 3

The training of new network personnel must also be accomplished in the shortest time frame with the least effect on network operation. This last comment must be carefully considered, for the most intense and rewarding part of training is always "hands on" in a live environment.

R&D Responsibility

The growth and evolution of the network is the prime responsibility of the R&D function of network management. Technology is expanding at a rapid rate due to the advent of competition and the intrusion of the microcomputer into the world of communications. This rate will not decrease in the 1980s. The network manager must be prepared to take advantage of every new advancement that may be integrated into the existing network. The prior statement is not the "ego" or "state-of-the-art" syndrome sometimes prevalent within the computer industry, but a management perspective intended to allow the network manager to bring new technology into the operational arena after thorough performance analysis and cost justification. The network manager should reevaluate his network topology and implementation every five years, with major complete restructuring, if required, taking place within two years of the evaluation period. Networks are service entities existing only to connect various hosts and user end points. Data applications are continuing to increase, and with the future bringing voice and facsimile into the network, R&D is a mandatory control element for the network manager.

As network designers turn more and more toward the vistas of structured network management, the analysis, monitoring and control of cost become increasingly important. The cost of effective network management can be divided into the areas of selection, operation and R&D. The selection of an implementation technique utilizing performance measurement and availability control becomes a management question of cost vs. performance. The cost of network management should be dictated by the rewards management will receive from its expenditures. The cost of *performance* control must include the license charges for computer vendor-supplied software, the additional internal costs for specialized data gathering and statistical report programming and the cost of associated vendor-supplied hardware. The cost of *availability* control must include test equipment, modem network control features, network supervisor hardware and software and various forms of circuit-quality monitoring devices.

The implementation cost of network management is a user's decision. The size of the network may not be the sole point dictating cost. Under normal circumstances, size equates to expenditure, but with respect to network management, network importance to the user through performance and availability may at times be an overriding factor.

The recurring operational cost of the network is an additional concern to management. The first directive of network cost management relative to operations is centralization of all diagnostic, control and maintenance dispatch functions. This centralization will result in a major reduction in "no-trouble-found," misdiagnosed and overtime maintenance calls.

The control of vendor maintenance may be taken a step further through the software implementation of a *vendor maintenance control system* (a user-supplied system independent of vendor aid). This system should be capable of monitoring the contractual performance of each vendor with regard to $MTTR_1$ and $MTTR_2$, generate empirical user-relative MTBFs, locate poor vendor performance areas, control the p.m. schedules based upon usage and develop a trend analysis of equipment failures. Through the use of the maintenance control system and centralization, the user can reduce recurring costs, increase reliability/availability and apply configuration management techniques to the network.

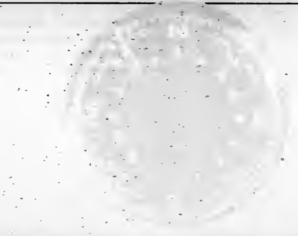
The application of cost control may also manifest itself in the area of vendor invoice analysis. This task, usually reserved as a corporate accounting function, has evolved during the last few years into a massive network management verification effort. This effort, utilizing network performance monitoring and the maintenance control system, is the only method available to network management to review vendor maintenance and/or common carrier invoices. This problem becomes acute when invoices for value-added/public packet services are part of the cost of the network. Without performance monitoring by network gateway or end point, no accurate verification of usage-related charges is possible by the network manager.

Lastly, the cost area of research and development. This cost must always be considered by network management. The evolution of the network can only be managed effectively if funds are expended on the continual analysis of growth and network topology.

The expenditures made by management toward R&D may also be used to generate cost reductions by taking advantage of new common-carrier tariffs or the new services of value-added/public networks. To this end, even the small network manager requires some degree of experimentation budget. That budget, as a rule of thumb, should be 5% of the total operational cost of the network.

This article has presented the multifaceted nature of network management. The ideas offered are applicable to all users, large and small. The '80s have all the signs of being the banner decade of network growth. Each user, in order to survive, must examine his own needs and tailor his own unique network management system to monitor and control budget, performance, and availability during this decade. ◆

By Herbert L. Gepner



DIRECTIONS IN DATA COMM SOFTWARE

Communications is the transmittal of information and ideas. Communications takes place between human beings and, in today's computerized society, between man and computer, or computer and computer. The primary goal of communications is to pass information from one entity to another in an efficient and understandable manner.

Communications with a computer requires several elements. First, an input device is needed to transmit the data. When people communicate, they use a special form of code called language. The same is true when man communicates with a computer. The language used in this case is a special code that is understood by the computer. The transfer of information (data) must be conducted electronically and with the help of specialized devices to assist man in inputting this information to the computer.

Second, a medium is required to carry that data to its designated point of delivery and, finally, a device is required to display that information to the recipient upon delivery.

Input devices have taken many forms over the years, starting with card readers and magnetic tape reels and working their way up to today's super-smart terminals. Transmittal media are usually referred to as channels or data links, depending on whether one is performing local or remote transmission of data. Finally, on the receiving end of this line would be an output unit, which could be anything from a printer to a CRT terminal or hard-copy terminal.

Let's take this simplified description of a data communications network and expand on it somewhat. As previously noted, we are interested in inputting data; sending it to a transmission point for processing and, after processing, directing the information to a desired termination point. In order to accomplish this we must have the appropriate hardware to accomplish the task along with a knowledgeable control mechanism, which we call communications software. Because of the fixed manner in which the hardware was designed to operate, the manipulation of data to meet specific requirements of the user has to rely on the logic built into a software entity.

Rapid Advancements

To appreciate the rapid advancements that have taken place in the field of communications, both hardware and software (because it is meaningless to separate the two), one has only to look back to that period in the evolution of data processing where everything was done in batch mode. The group inputting data usually did so via punched cards and either hand-delivered or mailed this input to the processing center. The information was then processed on a scheduled basis (if the user was lucky), which frequently would be the evening or next day after receipt of the data. The output, which usually took the form of large reams of paper, would be ready for delivery the following morning (again, if the user was lucky) and would wait in some bursting room until there was someone available to hand deliver or mail the output to the end user. Although far from efficient, the lack of experience with data processing made this an accepted mode of operation (for a very short period of time).

Then businesses and the volumes of company data started to grow, and this slow method of inputting and processing data was no longer acceptable. Large companies started to decentralize their operations, and delays in transmitting information from these outlying points to the headquarter's processing center sometimes caused losses in business opportunities, inadequate planning and generally slipshod operations. There was a demand for fast, efficient and accurate transmission and processing capabilities. The industry answered this demand quickly, and the answers were neither organized nor standardized (unfortunately).

The early networks comprised the connection of a terminal (or group of terminals) at a local or remote site to a single computer. The software controlling this network was not specifically designed for communications, but instead was usually an add-on to the operating system's basic device-handling capabilities.

Although minor degradation was noticed when operating in a communications mode, the early, low levels of traffic caused no great concern among DP managers. As the loads became larger and larger, however, the system slowdown became a great concern. To answer this need, the industry created the communications access method.

Almost every manufacturer of computer hardware was forced to develop an access method that would require the programmer to assume the burden of device handling, scheduling, synchronization and a myriad of other control functions previously handled by the operating system. This freed the operating system to handle non-communications-oriented DP chores, thereby decreasing somewhat the system degradation.

One of the most popular of these access methods was IBM's Basic Telecommunications Access Method (Btam). Although it was the most efficient method of developing and controlling communications operations at the time, Btam has fast been augmented by more highly sophisticated access methods, such as IBM's Virtual Telecommunications Access Method (Vtam) and Telecommunications Access Method (Tcam).

For those who are wondering, Btam is

Herbert L. Gepner is group managing editor/software at Datapro Research Corp., Delran, N.J.

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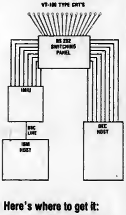

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"Application program development continues to be a major bottleneck in the implementation of data communications."

not dead. To the contrary, like the continued existence of the IBM 1401 payroll system, Btam programs are alive and well, and Btam applications are still being developed by a small elite group of diehard communications specialists.

The primary drawback of Btam is its device-to-applications dependencies, which result in increased complexity and redundancies in the programming effort. With Btam, the programmer is responsible for all the housekeeping required to manipulate the data being transmitted from a unique device (or group of devices). The access method has to be made aware of each terminal's operating characteristics.

Not long after the introduction of the Btam access method, the front-end processor was introduced. This hardware device assumed the responsibility of manipulating and untangling the various terminal and channel transmission characteristics, thereby presenting the applications program and access method with "clean" data.

Over the years, more and more logic has been moved away from the central processor into the front-end processor (currently called a communication controller) and even beyond to the terminal itself. This distribution of function minimizes data dependence within the application program and the operating environment.

Better Control

As networks became more sophisticated, the need for better control of the information being transmitted became more demanding. An answer was sought from the software developers.

In response, they vastly improved the access methods, incorporating such features as automatic data buffering, scheduling, line synchronization, error recovery, device independence and so on. The software routines became so highly technical that although still called access methods, they in fact were access systems.

Even this did not answer the user's needs for long. The use of access-method programming still caused lengthy implementation of a functioning network environment, not to mention overruns on development costs. Here again, the software engineers came to the fore. They created and introduced the telecommunications monitor. One of the earliest of these was IBM's CICS, which has grown (not always in an organized manner) to meet the constant onslaught of new communications hardware technologies.

The teleprocessing (TP) monitor was, and still is in many installations, considered the ultimate answer to the bottleneck situation created by lack of experienced personnel and the tight time constraints enforced in getting the communications network up and running.

The TP monitor acts as a separate task in the operating system, handling *all* communications functions that would normally require the stand-alone access method and/or the operating system. When using the monitor, a user could mix terminal devices in his network (that is, bisync, Synchronous Data Link Control (SDLC), teletypewriter and so on) without concern for their operational characteristics or application dependencies. Users could thus avail themselves of independently-marketed terminals at cheaper rates.

The TP monitor also controls operations such as message switching, polling, remote job processing and most other communications tasks that normally require special programming skills. The single most important advantage of the TP monitor is that users could now create applications independent of the network's operational requirements.

Almost every computer manufacturer offers a form of TP monitoring among its list of available program products. In addition, many independent software houses have created IBM-compatible monitors that can be integrated with the user's system configuration.

Some of the more popular compatible products include Com-Plete from Software AG of North America, Inc., Datacom/DC from Applied Data Research, Inc., Environ/1 from Cincom Systems, Inc., MPGSwift from Mathematica, Inc., Shadow II from Insac, Inc., Task/Master from TSI International (formerly Turnkey Systems), IDMS/DC from Cullinane Database Systems, Inc., Intercomm and Minicomm from SDA Products, Inc., and Westi from Westinghouse Electric Corp. These are only a few of the many offerings on the market, and their listing here does not reflect any preference or selection critera. Many other products not listed here offer as much or maybe more and should not be overlooked if you are in the market to acquire such a monitor.

A side effect of the evolution of the TP monitor is the introduction of applications development tools that can be used in conjunction with the monitor to ease the transition to the monitor environment and enable the user to realize more productivity from the monitor.

Application program development has been, and continues to be, a major bottleneck in the full implementation of many communications systems. Only a few years ago, the only accepted method of developing these programs was through the use of high-level language processors (for example, Cobol, Fortran, PL/I and so on). In the past few years, software developers have come up with an interpretive language approach to program development. Programmer productivity aids display menu-like screens from which the user/programmer selects the operations he wants performed by the application. Working with such aids, programmers can bypass many normal application development practices and can significantly increase productivity. One of the early examples of this type of tool is IBM's DMS/VS which is used with IBM's CICS/VS monitor.

We have covered access methods and monitors and how they have evolved and become an integral part of our everyday communications software environment. These forms of generalized software still do not meet the many

"The truth of the matter is there is currently no true standard which adds to the incompatibility in the U.S."

special needs of unique communications operations. An example is the office management environment, where word processing networks are fast becoming an extremely important factor in the business world. The marriage of word processing equipment and data processing (and communications) equipment has become a common occurrence. Other areas requiring specialized software include time-sharing operations, remote processing systems, multiprocessing hosts, videotex display, distributed data processing (DDP) and so on.

DDP Shaping Up

Not too many years ago, the term distributed data processing was coined. Originally, there were as many definitions of the concept as there were experts in the field. Today, DDP is starting to take meaningful shape. The nodal approach to DP, eliminating total reliance on the central host, has become extremely popular with large corporations that can afford to invest in the hardware and software expenditures to establish a workable system.

Data base management systems (DBMS), which have incorporated data communications capabilities in their design through the marriage of TP monitors (their own or independently supplied compatibles), are being designed to integrate distributive concepts as they relate to dispersed data bases.

One of the main drawbacks associated with DBMS/DDP integration is that the DBMS must be able to "talk to" the minicomputer at each node. This implies DBMS compatibility. Also, the terminals and computers in the network must be able to communicate in the same or compatible protocol. To date, this can only be accomplished in a theoretical sense, although some manufacturers are implementing systems with this criterion in mind.

"Protocols" and "architecture" are words that cause more concern on the part of the noninitiated programmer and manager than almost any other data communications concept. A protocol is the device-dependent language structure used to allow a particular type of device to communicate with another compatible device over a transmission line. Lately, we have heard a lot about the X.25 protocol, IBM's SDLC protocol and other standard or nonstandard protocols and the advantages or disadvantages of each. The truth of the matter is there is currently no true standard, a fact that adds to much of the incompatibility being perpetuated in the U.S. Because of different characteristics involved in transmitting data from one terminal to another, the specialized communications software development industry is flourishing and will continue to flourish.

Another factor contributing to the profusion of communications software is the architecture being fostered by the individual computer manufacturer. IBM's Systems Network Architecture (SNA) design is by far the most popular of these. SNA encompasses a total spectrum of IBM networking communications; that is, the logical structure, formats, protocols and operational sequences that govern information transmission through an IBM data communications system.

SNA Skeptics

SNA was less than universally accepted when first defined by IBM. However, IBM has released several iterations of system elements and increased the sophistication of the supportive devices over the last five years. Many IBM mainframe users therefore have accepted this communications philosophy with somewhat less reluctance. SNA-supported access methods and devices are available only with the virtual versions of IBM's operating systems. However, nonvirtual systems still support non-SNA designated terminals and controllers.

Although we often like to use comprehensive comparison charts when we relate similar technologies from a variety of vendors, in the case of vendor architectures, only a few consistently meaningful comparisons could be presented in chart form at this time.

It is more meaningful, therefore, to describe some of the software functions and implications associated with some of the more popular architectures. Because of the dynamic nature of the industry, the structures covered in this article may be joined by several new architectures by the publication date. There was no attempt to exclude any architectures from this report. The ones mentioned are those attracting the most attention from our readers at this time.

Four Components

There are four components that distinguish an SNA network: a programmable communications processor; Synchronous Data Link Control (SDLC) protocol; a layered concept for each communications operation; and specific terminals.

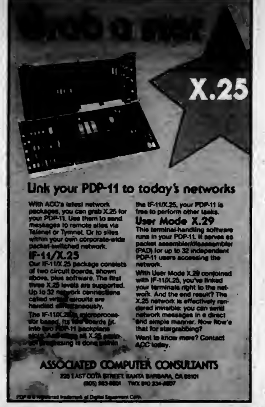
An SNA network requires at least one processor, such as the 3704 or 3705 communications controller. One such device must be configured with a host and perform the function of exclusive host control.

SDLC is the IBM line protocol indigenous to SNA. It is bit-oriented and can support half- or full-duplex transmission, point-to-point or multipoint lines and leased or switched facilities.

A standard precept of SNA is the separation of each communications operation into an Application Layer, Function Management Layer and Transmission Subsystem Layer. Each layer is represented in both the sending and receiving elements of a link, where it performs specific functions and defined responsibilities.

A wide range of terminal products can be employed in an SNA system, although each device's degree of programmability and protocol support significantly affects its communications efficiency within the network.

SNA supports two access methods: Tcam and Vtam. In 1976, IBM introduced an Advanced Communications Function (ACF), with a separate program product enhancement for both Tcam and Vtam. The most significant capability of ACF is the ability to in-



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"A distinguishing feature of DCA is its ability to support an environment of non-Univac processors and networks."

terconnect different operating systems and different hosts (including the most recent 8100 and 4300 processors), whether in the same or geographically different locations. Along with the access methods, SNA supports Network Management program products and Communications Controller program products.

DNA Philosophy

Digital Equipment Corp.'s Digital Network Architecture (DNA) cannot be compared with IBM's SNA. DNA was first introduced in 1975. Support for the Decnet Phase I products appeared in 1976, with Phase II following about three years later. With Phase II support, DNA brought together the unification of the PDP-11 and VAX-11 family of processors and associated terminals. Decnet capabilities were also extended to the Decsystem-10 and -20 mainframe systems.

The reported objective of DEC's DNA is to permit generalized interconnection of different host computers in point-to-point, multipoint or switched networks in such a way as to permit users to share programs, data files and remote terminal devices. With the release of Decnet Phase III, this goal appears closer. Along with incorporating support for the X.25 international protocol standard that has enhanced packet-switching operations around the world, Decnet Phase III introduces an emulator that permits DEC systems to be interconnected with IBM (and other supplier) mainframes running in an IBM SNA environment.

DNA also employs a layered methodology. DNA's structure consists of six functionally separate tiers: a User Layer, where the message originates; the Network Application Layer, where control information relating to the message is appended; the Network Services Layer, which handles the movement of the message between the modules of various other layers; the Transport Layer, which can be equated to the telecommunications access method of a large mainframe; and the Data Link and Physical Link Layers, which ensure that the message is transmitted error free to an adjoining node.

The Digital Data Communication's Message Protocol (DDCMP) is DNA's byte-oriented link protocol, which is similar in structure to IBM's bisynchronous protocol.

Honeywell, Inc.'s Distributed Systems Environment (DSE) is not formally referred to as an architecture, but more as a "concept in communications processing." DSE is not a rigid framework for network implementation. Any two Honeywell processors, remotely connected, could be considered a DSE system, as long as some degree of similarity in application functionality exists.

The classic DSE network includes a host, with a front-end or integrated communications processor; one or more remote or satellite processors; and terminals. The High-Level Data Link Control (HDLC) is the standard protocol for interprocessor links within DSE. HDLC is a bit-oriented, synchronous protocol and is an implementation of the International Standards Organization (ISO) specifications.

DSE, as the name implies, embraces distributed processing — the placing of application processing at the user site, thus relieving the host of some of its processing burden. In addition, DSE supports distribution of data bases and data base management functions.

DCA Features

Sperry Univac's Distributed Communications Architecture (DCA) describes the interaction of its currently available communications hardware and software components through which networking is achieved.

DCA embraces the concept of distributive networking, similar to Honeywell's DSE philosophy. DCA attempts to relocate communications control logic away from the central processor. One of the distinguishing features of DCA is its ability to support an environment consisting of non-Univac terminals, processors and networks. DCA also provides several modules as standard options which support IBM terminal handlers (emulators) and protocol compatibility with X.25 packet-switching services. In addition, an Adapt Feature permits the user to define virtually any terminal or communications protocol which is now available.

Univac's standard protocol is the Universal Data Link Control (UDLC). Like IBM's SDLC, it is a bit-oriented, synchronous link protocol based on the ISO HDLC and the Ansi Advanced Data Communications Control Procedures (ADCCP) standards.

As noted earlier, many other vendors have developed, or are developing, architectures unique to their product offerings. We would expect that in the very near future, almost every major

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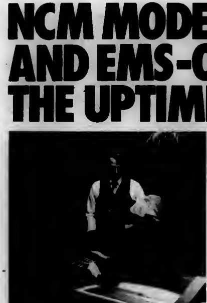

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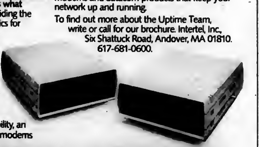

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"Software technology no longer lags hardware. Rather, new software developments are dictating the need for new hardware."

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Needless to say, this article cannot possibly cover all the various aspects of communications software that prevail in today's environment, or those that are currently being developed or planned for the future. A book would be needed: In fact, several books would barely be sufficient to cover the subject. We have just touched upon some of the more talked-about aspects of communications software. Now, let's turn our attention to what we see for the future.

Hardware, Software Gains

We predict that there will be no slowdown in the design and development of faster and more efficient hardware, which will dictate that the software become more independent of the operating environment of the host or nodal terminals. This will involve more functions being incorporated into front-end processors, controllers and terminals in the form of microcode.

The need for protocol standardization is imperative, and we predict that standardization will take place within this decade. It is probable that the accepted standards will fall somewhere in between what IBM is willing to support and what the rest of the industry is willing to accept.

It is important that software supporting one set of devices be able to communicate directly with software supporting different devices. To effect this mode of operation, "portable" software must be devised. This means that a common language must be developed that will make this heterogeneous handshaking environment feasible. This, too, will more than likely occur in the decade of the '80s.

More sophisticated software will be developed to support telephone and television viewing data bases (for example, Viewdata, Prestel and so on).

Multiprocessor, multinodal communications will continue to expand in sophistication, especially in local word processing-oriented business environments.

TP monitors will get bigger (and better?) and will become an accepted part of all future DBMS environments, which will also include support for distributed data bases, inquiry/response, report generators and so forth.

We also predict significant improvement in the software-supporting remote processing services, especially in the area of packet-switching systems. Networks supporting literally thousands of terminals are not very far off. By 1985 this support could become a reality.

Within the next five years, we will also see almost complete acceptance of IBM's SNA philosophy by IBM users, if for no other reason than that it will be all that is available to them, but we can look forward to a user being able to interface non-SNA environments with an SNA host configuration node.

The educational world will be enhanced through the increased use of interactive television cable communications, allowing remote schooling at home, in remote locations and even worldwide via satellite. Computer-aided instruction will also become more viable (meaning less expensive) in the '80s.

There are two communications technologies that we have not covered directly in this article: electronic mail and point-of-sale (POS) systems.

Electronic mail technology is currently where distributed data processing technology was about three years ago — in its infant stages. No one knows exactly where it is heading, but they know it is needed. Within the next five years, we predict that this muddle will be straightened out, and great strides will be noticeable throughout the business community.

POS technology is currently in the process of becoming more legitimate than ever before. Again, because of advanced hardware technology, the software supporting retail and POS systems has become more sophisticated. Now, if we can get the users to exploit that software to realize the potential it offers, faster POS installation/utilization statistics will be recorded. Will this acceptance take place soon? We think not; the end-user organizations are very conservative. It will be more than five years before the cost-efficiencies are so clear that management will readily embrace this approach.

In order for all of this to come about, and we have to doubt that it will, manufacturers will have to invest a great deal of money in the research and development of new technologies. It is safe to say that we have reached a point in the growth of the communications industry where the software technology no longer lags hardware technology by the leaps and bounds of yesterday. In fact, new software developments are generating new ideas and dictating the need for new hardware.◆

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DATA COMMUNICATIONS SOFTWARE VENDORS

It would be impossible to identify all the suppliers of data communications software. Almost every company that manufactures a communications device is a potential supplier of device-dependent software. In addition, many software innovators are constantly taking up the challenge to produce specialized software for the communications industry.

This listing identifies 75 communications software vendors that appear in the Datapro Directory of Software and who are among the top producers of communications software identified by our readers. We know that there will be many readers who will say, "Why wasn't my company represented in that list?" To these readers we extend our apologies, but the line had to be drawn somewhere, and the sources of vendor information are unlimited.

The list is broken down into eight separate categories. Each category contains the names of vendors who are noted for software addressing that segment of the industry. Each vendor is listed in only one category, so those vendors who offer several different types of software can be located in that category, which has been identified as the one most familiar to our readers.

The computer manufacturers are clustered in a separate category at the end of this list because they frequently offer communications software that addresses the entire spectrum of software support.

All addresses and phone numbers are current as of January 1981.

TP MONITORS AND TRANSACTION PROCESSORS

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- **Applied Data Research, Inc.**
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  (201) 874-9100
- **Benson-Varian, Inc.**
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  Mountain View, Calif. 94043
  (415) 965-9900
- **Cincom Systems, Inc.**
  2300 Montana Ave.
  Cincinnati, Ohio 45211
  (513) 662-2300
- **Cullinane Data Base Systems, Inc.**
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  Westwood, Mass. 02090
  (617) 329-7700
- **Cybertek Computer Products, Inc.**
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  Culver City, Calif. 90230
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- **Digital Research, Inc.**
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  (408) 649-3896
- **Informatics, Inc.**
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  Canoga Park, Calif. 91304
  (213) 887-9121
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By John M. Eger

THE INTERNATIONAL INFORMATION WAR

"It is only the accident of the briefness of our lives in relation to the speed of evolutionary change that makes the pattern of life seem static now; and it is the folly of self love that leaves us satisfied with that."
— *Isaac Asimov,* Homo Obsoletus

We are living in a period of enormous change — political, economic, social — as the U.S., together with other industrialized nations, rushes headlong into a postindustrial, interdependent, information-based age.

These changes are driven largely by developments in the computer and telecommunications industries which have permitted increased communications over longer distances, at greater speeds, at ever-diminishing costs, virtually shrinking the globe. Indeed the merging of data processing and communications technologies has accelerated increased global interdependence on both a geopolitical and macroeconomic level. This marriage has also created another kind of technology, so-called "information technology," the total value of which is greater than the sum of its parts.

Not only is such continued change inevitable, it is occurring at sufficient rate to cause serious insecurity among nations, developed and developing alike. For technology has outstripped the existing legal framework and widened the gulf between society's ability to understand the fact of change and its impacts. It has created a vast wasteland of misconceptions and misunderstandings and, in the process, a growing legal vacuum.

Even vocabulary created to describe this phenonmenon is cumbersome and ill-phrased. For example, terms such as informatics, informatique, telematique, tele-informatique, tele-informatics and compunications (sic) have been devised, although, at this time, none shares a precise meaning.

Prof. Fermin Bernasconi, the director general of the Intergovernmental Bureau for Informatics (IBI), has defined informatics as "the national management and exploitation of information resources according to a strategy implemented by appropriate policies."

In Brazil, the term informatics has been stated with greater specificity to ensure development of indigenous computer/communications industries and to deter imports of any kind that might adversely affect that goal; thus, the Brazilian definition encompasses any information, data processing or telecommunications products, equipment or services, software or hardware imported or manufactured in Brazil.

To foster the development of the "information society," the French government has established a cabinet-level position with responsibility for full development of the telematique concept, which recognizes the pervasive impacts occurring when telecommunications is added to the informatique mix. The French program has direction, resources and a highly developed focus compared with informatics plans of other nations, including Brazil. For such a highly developed country, there is also an anxiety, a new and unique urgency not evident, at present, in other national plans.

Nora/Minc Report

The blueprint and catalyst for the French plan was the Nora/Minc report on the informatization of society. This was the first and definitive informatics report, defining not only the technology but the effects of its various applications according to matters of national importance. Concentrating on the highly volatile issues of microelectronics and unemployment, Nora/-Minc forecast a 30% reduction in jobs, related to insurance and banking alone, within one decade — thus putting informatics on the front burner of public policy issues.

As early as 1977, Louis Joinet, then a magistrate of the Department of Justice for France, framed the debate succinctly: "Information is power," he said, "and economic information is economic power."

"Information," he continued, "has an economic value, and the ability to

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John M. Eger is a Washington-based attorney and consultant on telecommunications and information policy. A more comprehensive and detailed version of this article will appear in a "Symposium of Tele-Informatique," Cornell International Law Journal, Summer 1981.

> **"Developing countries recognize information as a powerful resource with political, economic and social consequences."**

store and process certain types of data may well give one country political and technological advantage over other countries. This in turn may lead to a loss of national sovereignty through supernational data flows."

More recently, a French economist, Alain Madec, chairman of the French Commission on Transborder Data Flows, concurred, expressing the view that without government diligence and anticipatory action, the nation-state could find itself in a state of decay, subordinate to the multinational corporation.

"Compunications," a term coined in the U.S. by a Harvard professor of information policy, stresses the computing aspect of this marriage of computer/telecommunications technology. While the term is awkward, the converse U.S. emphasis on data processing may not be accidentally placed. U.S. law or policy has not addressed the implications of these developments sufficiently to afford us the ability to coin our own word — thus the "pun" in compunications may aptly refer to the punishment the U.S. can expect for its nonfeasance.

Last, tele-informatics, another nascent concept, describes the total concept of information collection, storage, use and transfer, and both the socio-economic and political implications of those processes on the health and well-being of both the public and private sectors.

Data protection laws, telecommunications tariffs and protocols and informatics plans have been adopted around the world, set only in rare instances against broad national policies by nations on an individual basis to accommodate real and potential impacts of an unrestrained global market for information goods and services. Yet, the worldwide movement toward significantly increased regulation of business and personal information, controls on the export and import of all kinds of international information flows and constraints on the use of the technology for collection, storage, use and dissemination is becoming clear. Likewise, the confusion and even chaos in international affairs invited by the increasingly apparent legal void looms large on the horizon.

The Information Stakes

The current meaning of the word "information" is broad. Information no longer refers to conventional bodies of statistics, facts, academic knowledge, scientific data or daily news. It now includes electronic sensing and computer analysis of the human heartbeat; electronic impulses measuring physical phenomena in outer space or in research probes beneath the sea; and numeric digits holding your seat on a plane or transferring funds to and from your bank account. No matter how information is stored or recorded, whether on film, paper or magnetic tapes, or in books, magazines, instruction manuals, movies, television or electronic computer memories, it is part of the growing information industry.

We have become increasingly dependent upon these various forms of information for the growth and health of the economy, the smooth functioning of institutions and the quality of our individual lives. In simple terms, information has become a marketable, transferable, exportable commodity — a commodity for production, sale and consumption with which more and more of us are engaged every day.

In the U.S., Commerce Department studies have revealed that more than two-thirds of the U.S. work force is now employed within an "information-based" service sector, making a contribution of 65% to the gross national product and approximating 25% of total U.S. exports. U.S. trade in "invisibles" or services already represents a bright spot in the U.S. trade picture.

West Germany, Japan, France and other member countries in the Organization for Economic Cooperation and Development (OECD) are experiencing the same trends, analyzing these developments, attempting to ascertain the probable impacts on their national infrastructures, developing responsive national policies to accommodate and foster the orderly and healthy introduction of new information technologies and assessing the need for increased government intervention.

In Developing Nations

As implied, this awareness is not limited to the developed countries. More than 50 developing countries have adopted comprehensive national informatics plans, recognizing that information is a powerful resource with political, economic, social and cultural dimensions which, Bernasconi stated some years ago, "is motivating governments to consider regulatory or other policies to protect or promote their national interests."

The U.S. and all developed nations are justifiably wary of informatics

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"Privacy has rapidly emerged as a significant factor in corporate strategic planning on an international level."

plans designed out of an apparent narrow self-interest or fear of abuse, data protection laws with a protectionist underpinning, exploitive telecommunications tariffs and other barriers to the free flow of information and free trade of information goods and services.

What follows is:

- An attempt to survey the first wave of potential barriers to international information flows rapidly emerging and posing a threat to a world already highly dependent on the free flow of information and unrestricted use of information technology.
- Some suggestions for the U.S., virtually alone among developed nations in its failure to adopt or formulate even an approach toward a national information policy.
- Thoughts on the need for a new regime of international law and policy.

The Emerging Barriers

There are five areas of new regulatory and policy development rapidly emerging that pose serious threats to the free flow of information:

(1) Privacy and data protection laws.
(2) Telecommunications tariffs, standards and protocols.
(3) Informatics strategies.
(4) National responses to computer vulnerability.
(5) Assertions of national "information" sovereignty.

In discussing each, recognition must be made of the legitimacy of each nation's desire to develop national policies responsive to its future — economic, social and political — as the nation has defined it. Such policies may include the development of an indigenous data processing industry, inclusive of microelectronic chip manufacturing and software development. In the same way, development of an indigenous telecommunications industry including optical fibers, satellites and computer satellite links may also be perceived as necessary.

The perceived need to control the byproduct and raw material of an information-based economy must also be understood as information commodities increase in value and become critical to the health of national economies in so interdependent an environment. Without such developed control, many nations perceive themselves to be vulnerable to unreasonable external pressures and dependent on foreign sources of information for their national development.

Privacy and Data Protection

Privacy, or "fair information practices," as it is popularly termed in the U.S., has rapidly emerged from total obscurity just 15 years ago to become both a legitimate public policy issue and a significant factor in corporate strategic planning on a national and international level.

Concern has arisen largely in response to the convergence of telecommunications data processing technologies which facilitate fulfillment of business' and society's increased needs for information. One of the earliest laws to deal directly with the hazards computer technology itself has introduced was the 1970 Data Protection Act of the State of Hesse (Federal Republic of Germany), which specifically addressed the problems of privacy and security of data prepared for automatic processing. While not comprehensive in scope or jurisdiction, it became the focus along with an earlier but also defeated measure, entitled the 1969 Data Surveillance Bill of the UK, for privacy consideration in academic forums and within the Council of Europe, Nordic Council and the OECD in the early 1970s.

Collection, use and storage of larger volumes of more intimate information raise fears that technology will be exploited to misuse personal data. In addition, as the individual increasingly surrenders control of more personal information to public and private data banks, a "need to know, correct and amend" information is created on a human rights level to restore some measure of control for the individual over personal information and therefore over the decision-making criteria used by third parties regarding them. This is as true in the U.S. as it is abroad.

The 95th Congress introduced 100 bills addressing privacy, and in the 96th Congress comprehensive legislation addressing medical, research, financial and insurance records was vigorously supported by the Carter White House. Meanwhile, 24 other nations have either enacted omnibus privacy or data protection legislation or are in the process of doing so.

The global ground swell of support for assurance of individual rights is highly credible. However, these same laws, particularly those stressing the macro "data protection" aspect of record management, in which data of all kinds is of concern — rather than individual privacy based on human rights

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> **"Crucial differences exist between the European and U.S. approaches to the assurance of individual privacy rights."**

considerations — may pose serious threats to international commerce.

While all the laws have their own peculiarities, they have several elements in common: registration or licensing of data banks is required; both private and public data banks are covered; some manual, but primarily automated files only are included; limitations on the length of time data can be retained are imposed; secondary use, sharing and dissemination of data are regulated; rights of access, notice and correction of obsolete or incorrect information are established; a national, central authority is created; a responsibility for security and confidentiality of records is attached; prior authorization for transmitting data out of the country is required; and sanctions including imprisonment are applied.

Differences in Approach

Despite a shared point of departure, at least on a manifest level, that is, human rights, crucial differences exist between the U.S. and European approaches. In the U.S., legislation is pursued on an incremental, "as-needed" basis. Most other nations have adopted an omnibus, prophylactic approach. Moreover, the U.S. approach to privacy is restricted to individuals or natural persons, whereas Europe continues to press for coverage of legal persons, including corporations, associations, trade unions and so forth, raising vast, still little-understood problems of competition, trade secrets and confidentiality.

This trend away from privacy and the protection of natural persons — and toward data protection and the inclusion of a wide range of economic, political and personal information — seems clear and inevitable when considered in tandem with emerging teleinformatics strategies and heightens the need for international negotiation and cooperation.

The OECD, Council of Europe, European Communities and Nordic Council have already initiated policy programs on privacy and data protection. The U.S. has participated in only one of these forums — the OECD (of which the U.S. is a member) effort to formulate a set of nonbinding, voluntary guidelines to assure the protection of personal privacy as personal data transits international borders. The guidelines were negotiated by a working group of experts on information, computers and communications over a three-year period and were completed in September.

The U.S. is now actively promoting the guidelines as minimum standards for corporate behavior. Despite the permissive, nonbinding nature of the guidelines, it is anticipated that their adoption in spirit will do much to ameliorate or eliminate many of the concerns expressed by other nations regarding the security of personal data that transits or is processed in the U.S. and therefore the barriers to international data flow.

Essence of Guidelines

Very broadly, the guidelines outline basic privacy principles and data subject rights, concluding that:

- The collection of personal data should be limited and, wherever possible, undertaken with the knowledge and consent of the subject.
- The data collected should be relevant to the purpose for which it was collected, which should be specified prior to or at the time of collection.
- Data should be complete, accurate and current.
- Data should not be disclosed to any other party than that originally specified, except with the consent of the subject or under authority of law.
- Keepers of information should take all reasonable precautions to protect the security of the data against unauthorized access, use or destruction.

Furthermore, the individual data subject is accorded the following rights:

- To know of the existence of data should he request confirmation.
- To have the data relating to him communicated in comprehensible form, within a reasonable time and at reasonable cost.
- To know of the reason for any adverse decision and to contest the grounds.
- To contest the accuracy of data and assure correction in the case of proven inaccuracy.

European Convention

The Council of Europe, of which the U.S. is not a member, also finalized a "Convention for the Protection of Individuals with Regard to the Automatic Processing of Personal Data" in September — effective after five countries have ratified it. The convention is binding on its signatories and assumes treaty status. The U.S. may accede to this convention if it so desires; however, the document calls for passage of complying or enabling domestic legislation as a condition of accession, a requirement that will doubtless discour-

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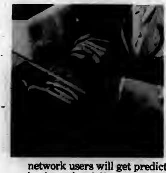

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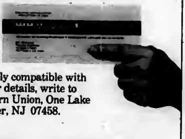

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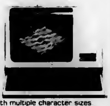

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Graphics. Added Value From National Computer

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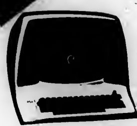

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"Nations are struggling to determine the role of computers, telecommunications and information itself in their economies."

age U.S. government or corporate support.

Although the parties are the same and the general principles similar, the convention requires the passage of enabling legislation which may include the coverage of "legal persons," while the OECD is totally silent on this matter. Moreover, the convention, in requiring national legislation as a condition of reciprocity, suggests a country may deny export of data if the receiving state's legislation is inadequate — or worse, the state does not have any.

Some European data protection authorities have hinted that the European convention and the OECD guidelines are "complementary" — a euphemism for the proposition that personal and corporate data collection, processing and transfer functions are vulnerable unless they and the receiving states in which they do business subscribe to both instruments of international law. To accept this argument requires an acknowledgment that the OECD guidelines are meaningless and the three-year exercise that produced them a sham.

The U.S. negotiated in good faith, fully recognizing Europe's approach toward anticipatory, prophylactic and omnibus legislation and its desire to bind itself in a treaty. This, however, only makes the convention "complimentary," not "complementary" to the guidelines. Of course, if U.S. and non-European members do not embrace the guidelines and affirmatively demonstrate their sincerity, the voluntary approach will be rendered a useless exercise; and U.S. adherence to the council's convention — requiring reciprocal national legislation — may be the only nonvoluntary alternative.

Another concern is the potential for protectionism these data protection laws pose. Nations are struggling to determine the role of computers, telecommunications and information itself in their national economies and the extent of government intervention required. The desire for increased revenues and an indigenous data processing industry is motivating countries to require that all processing be performed locally and to eliminate private or user-controlled telecommunications networks. "Informatics" plans or national information policies are also being developed around the concept of "information sovereignty," a notion that information or data that is produced within a nation belongs in some way to the nation of origin — so its export may be denied or taxed.

Whether data protection laws are the instruments of the new protectionism is onclear, although some countries such as Luxembourg have already declared their laws were designed not only to protect the privacy of natural persons, based on human rights considerations, but to regulate and control data or information of all kinds that may be necessary to preserve the political, cultural and economic security of a small country.

Adoption of the OECD guidelines will not eliminate these concerns. Each will have to be addressed over the course of the decade, hopefully before increased tensions over unemployment, inflation and world trade force us into a "law-of-the-sea-type" conference over communications and information.

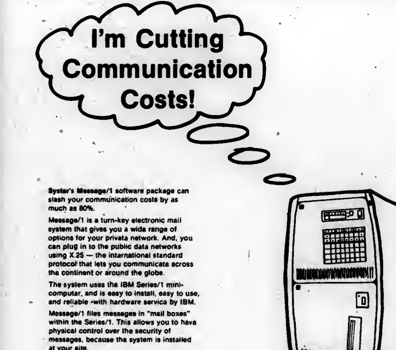
But adoption of the OECD guidelines now — by U.S. business — will put us squarely behind privacy (where we have always been conceptually, or as a matter of policy). Equally important, adoption now in full compliance with the spirit of the guidelines should permit the continued free flow of information in the world, vital to a delicate international system of business and finance on which every nation depends.

Tariffs, Standards, Protocols

In contrast to privacy and data protection laws, barriers raised by increased tariffs, higher or different standards or protocols or policies making the use of foreign equipment difficult to import are more obviously economic in nature and directly affect the cost, management control and effectiveness of the information systems of a multinational corporation.

In most parts of the world, authority for telecommunications policies rests commonly and exclusively with a PTT, or postal, telegraph and telephone monopoly. Louis Pouzin, one of Europe's leading system designers, has argued that telecommunications tariffs and regulations are more effective and proven tactics for preventing the exchange of information than almost any other means. Several examples can be cited including the cost per mile of a leased telephone line in Europe which is three to five times higher for international links than for domestic ones.

According to Pouzin, a persisting policy of the European PTTs is to discourage international communications. He told those attending a 1978 Interface conference that: *"Monopo-*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"The PTTs want the revenues from the burgeoning growth in data communications, thus their facilities are available at ever-increasing cost."

lies have little incentive to offer better and cheaper services. International services aplit revenues and create additional burdans. But this :cannot be the whole explanation.

"I would guess that several European countriea including France will attempt to control the development of American networks. By keeping international tariffs high enough, it will becoma more aconomical to install processing centers in Europe. The problem of protecting data will be simplified."

But tha PTTs or the nation-states want more than just control; they want the revenues from the burgeoning growth in data communications. Thus, the user, who may have found the PTTs most cooperativa in offering dedicated facilities for laase — so-called private lines — now finds such facilities unavailabla or availabla only at an avery-increasing cost.

Multinational corporations with their "privata"-line natworks, it is being urged, aroda actual and futura PTT ravenues because they are developing their own intarnational alectronic messaga systems, computer-to-computer networks and othar information systems which competa directly or indirectly with existent telex services offered by tha PTTs, or with thair own national "alectronic mail" services still in the davalopmantal stage.

There is an undarstandable, gold-rush-like effort by PTTs to develop their own national natworks capable of handling voica, data, video or facsimila traffic in abundance, and this isolates it from such indirect competition.

Privata Leased Lines

A first step in tha alimination of privata laased lines occurred within the Consultative Committee on International Talephone and Telegraph (CCITT), tha administrative arm of the International Telecommunications Union (ITU), responsible for talecommunications regulation.

Tha CCITT first officially haard a proposal to aliminata the offaring of private leased lines from the Italian delegation to a 1977 meeting which claimed that such leases were an anachronism in today's anvironment and should be eliminated in favor of transferring tha traffic onto the public data network, which would than price on a volume basis. Tha resolution is still pending. Navartheless, the ground swell of interest that it created aided tha adoption of another recommendation that permitted volume-sensitive pricing of Swift, a financial transfer network which is provided through private leases. This mova hava been interpreted by some as an incremental step toward elimination of private, transparent lines leased on a flat-rate basis.

The trend away from tha private laased lines seems clear, although not to the degree that the service is eliminated completely. Adoption of volume-sensitive pricing is a more logical development achieving the same end — over time, without the confrontation. Evan in the U.S., a recent Federal Communications Commission (FCC) decision determined that residential long-distanca volume-sensitively priced service or message telephone service (MTS) is essentially the sama service as Wats, or bulk-priced Wide Area Talephone Service. This decision may not effectively eliminate the offering of tha Wats service, but certainly renders the service more expensive and, for soma, prohibitive.

Access Debate

A related and equally important area of dispute is tha debate over access. Recently the German Bundespost issued

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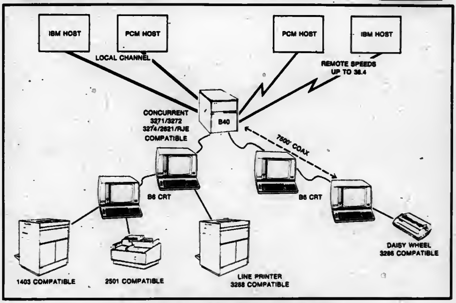

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"Transborder data flow restrictions appear as stopgap measures when viewed against the visionary development of national informatics plans."

regulations specifying that, effective this year, no private entity may attach enhancing equipment such as concentrators or nodes to private leased lines linked to centers in other countries. The choice presented is connection to the new volume-sensitive public switched network that the German and other PTTs are promoting or the placement of computers within Germany to perform "significant" local processing prior to international transmission.

Both alternatives are expensive and create havoc for remote computing service companies and multinational companies alike, which have spent a fortune establishing efficient data transmission methods and large computing centers which process huge volumes of data 24 hours a day for customers in different time zones around the world. Also reported are indications that Britain, Sweden and others intend to follow suit.

Access has also been paramount as a problem for U.S. time-sharing and data processing service organizations in their commercial relationships with Japan. After lengthy negotiating, restrictions embodied in contracts between Control Data Corp. and Tymshare, Inc. with the Japanese international record carrier, KDD (Kokusai Denshin Denwa Co., Ltd.), included:

- Limitations on the transfer of data between Japan and the U.S., justified by an onerous interpretation and application of Japanese law limiting the range of services provided.
- A requirement that when KDD's Venus network is operational, each company will transfer to this service, which is a public, usage-sensitive network that will increase costs significantly.
- For Tymshare, a submission to detailed and thorough inspections of its computer center, including proprietary software. (It should be noted that KDD's sister agency, Nippon Telephone and Telegraph [NTT], which provides domestic telephone service, is also the largest domestic provider of computer services.)

Curtailing CDC's and Tymshare's ability to compete in the Japanese data processing markets by imposition of these limitations gives NTT a significant and unfair advantage over its American competitors, directly related to KDD's control over U.S.-Japan international communications circuits; it also artificially promotes an indigenous Japanese data processing service industry by "protecting" Japanese markets from international penetration.

Protocols and standards comprise yet another fertile area for concern. The CCITT is the appropriate forum, again, for such determinations and will doubtless provide the arena for major debates as international teletext, videotex and home information systems emerge.

Informatics Plans

Transborder data flow restrictions, arbitrary telecommunications tariffs and regulations developing at a rapid rate within the last few years appear increasingly as stopgap, short-term measures when viewed against the more visionary development of national informatics plans. Indeed, the data protection laws and computer access restrictions which limit or may effectively limit or inhibit the free flow of data today may be more braking measures for the compelling forward motion of technology than ends in themselves.

Informatics plans, broadly stated, harness the essential elements of information resources in much the same way as the full implications of dependency upon any other resource such as coal or oil

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> "Present informatics plans fail to accede to the most elemental factor in the tele-informatics environment — global interdependence."

would be approached — followed by the crafting of a plan to emphasizt positive development and circumvent negative results through national preparedness.

Such informatics plans or strategies, while tending to vary according to generic definition, generally encourage industry development, support robust use of data processing and communications technology and generally are in the national or best interest of the people. However, the nationalism and concentricity of present informatics plan development fail to accede to the most elemental factor in the tele-informatics environment — increasing global interdependence, necessitating increased harmony and coordination in the regulation of information and increased exchange of information.

Comments by less-developed countries (LDC) at the June World Conference of the IBI, coupled with the Mass Media recommendations approved by the United Nations — stemming from the MacBride (Unesco) Commission — and political developments witnessed at the 1979 World Administrative Radio Conference (Warc) indicate an increasing desire on the part of developing countries to focus on internal profit and concerns resulting in positions negating broader solutions.

Of particular interest to the U.S., the French Nora/Minc Report raises the issue of potential corporate (primarily IBM) dominance in national affairs and the need to contravene this development. Another study contemporaneous with Nora/Minc and performed under the auspices of the French Ministry of Industry and Research (Treille) was released with strong recommendations for reduction of the American influence in French affairs by curbing U.S. corporate operations. This year the economist Alain Madec also promoted the need to diligently diminish the threat of corporate influence to maintain national supremacy over national affairs.

Madec Plan

Madec has set the stage for the national development of a scheme for quantifying, classifying and logically taxing certain kinds of data flows. In his remarks before a recent OECD High Level Conference on Information Policy in October 1980, he recommended a fourfold, interrelated classification scheme comprising:

1) *A legal classification* distinguishing between public and confidential data.

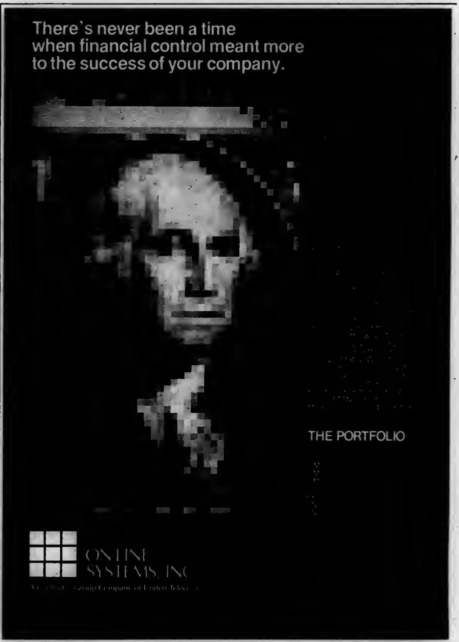
2) *A commercial classification* distinguishing information that is and is not for sale, which would permit regulation of property rights.

3) *A functional classification* clarifying the diversified roles of the information carrier as a distributor, a conduit for meaningful two-way communication or as a central nervous system.

4) *An economic classification* defining information in terms of its contribution to the process of creating a final product, in the form of software or data, or indeed as the final product in the form of a message. Here Madec differentiated between the most crude "data" and the most sophisticated "information."

The Intergovernmental Bureau for Informatics (IBI) has also determined that one of its first working groups must address, among other issues, the internal data flows within transnational corporations, which will necessitate the "preparation of topologies of data" — means to "valuate and measure data products" and "internal company data flows."

Once this is achieved, IBI working parties will address traditional international trade practices that allow "unfet-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"Already, many less-developed countries advocate a right to control all information gleaned within the borders of a nation-state."

tered" intracorporate communications; examine the option of prohibiting export of certain types of data to protect national security; and address the "problem of balance" in information flow, which may necessitate the creation of an international mechanism to control the operation of transnational information.

Already, several less-developed countries advocate a right to exercise control over any and all information gleaned within the borders of a nation-state. Colombia recently lost a bid to tax earth-sensing satellites orbiting above it on the grounds of trespass. However, its persistence will likely continue as the concept of information sovereignty is refined.

Canadian Concerns

Canada's answer to Nora/-Minc, the so-called Clyne Commission Report issued in 1979, raised similar concerns over the potential for national dependence on technologically advanced and aggressive nations such as the U.S.

In a period when discussions over international communications policies and problems were dominated by transborder data flow and privacy concerns, Hugh Faulkner, Canadian Minister of Science and Technology, anticipated the present debates when he argued that the problem with transborder data flow was that it *"creates the potential of growing dependence, rather than interdependence, the loss of employment opportunities, in addition to the balance of payments problems, the danger of loss of legitimate access to vital information and the danger that industrial and social development will be largely governed by the decisions of interest groups residing in another country."*

The Clyne Commission Report addressed each of Faulkner's fears, detailed a slate of recommendations across a broad spectrum of economic and social activities and specifically recommended that data processing activities, including systems development and programming, related to Canadian business operations be performed in Canada, despite the duplicative effect that this move might have. Indigenous data processing is intended to both preserve employment opportunities in a market where labor demand is shrinking anyway and to preserve control over Canadian information as a raw material and national resource.

On a regional level, in the developed world, the European Economic Community (EEC) has also been primarily concerned with the development of a strong data processing industry. And, not surprisingly, the plan proposed by Commissioner Etienne Davignon, to capute one-third of the world market by 1980, includes:

- Standardizing components in computing.
- Removing nontariff barriers to trade between EEC countries.
- Opening up competition for each national government's contracts to all EEC companies.
- Providing more research and development money for computers and chips and better coordination of national research programs.
- Establishing an "integrated digital network" for telecommunications, so that video systems, computers and more conventional telecommunications can be linked by the same network throughout the EEC (Euronet is a step toward this end).
- Cutting tariffs on components the community does not manufacture, and perhaps raising tariffs on components it does.
- Beginning studies to set up a telematic network for the

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"The development of an informatics plan is not inherently evil. Indeed, there is a consensus that every nation must formulate one."

community institutions.

The development of national strategies or so-called data protection information laws or informatics plans is not necessarily inherently evil or somehow contrary to international harmony. Indeed, there is growing consensus that every national must formulate a national information plan or policy of its own.

Troubling to most observers, though, is an intellectual enchantment with the concept of a "post-industrial, information-based" economy and society, which fosters the creation of an "information elite." This causes an overreaction and with it the development of unnecessarily restrictive, even counterproductive information laws, taxes, tariffs, regulations and policies which, once articulated and "on the books," will be difficult to remove or amend. Once enshrined in national law and policy, these restrictions will ultimately serve to exacerbate the more orderly development of international or world law and communications policy so badly needed.

Computer Vulnerability

The arguments over national computer vulnerability mirror those put forward over the need for increased privacy protection for the individual. National governments, like individuals, have become more dependent upon computers and telecommunications to store and process information relating to national agriculture, commerce, vital services and, most notably, national defense. Moreover, multinational banks and others doing business in one country routinely transfer around the globe volumes of data essential for government uses as well.

The negative impact a country would sustain in the event of a temporary or sustained denial of access to such data defines its quotient of computer vulnerability.

Although this is clearly an area of legitimate governmental concern and action, severe regulation can pose barriers to international commerce on a par with needless or overly protective privacy laws or telecommunications standards and restrictions.

While in the U.S. the Department of Defense, other critical agencies of national security as well as numerous defense- and intelligence-oriented "think tanks" have examined the "vulnerability" of U.S. information systems, little public discussion has been forthcoming. A private trade group, however, is now in the process of drafting a paper, "Observations on Vulnerability of Computerized Societies."

Elsewhere, only Sweden has published any substantive work. The Ministry of Defense established a committee in 1977 to investigate the vulnerability of the computerized society and to propose measures to reduce this category of weakness. One particular event did much to prompt the study.

Experimental Project

In an experimental data communications project linking the Swedish towns of Ottenberg, Stockholm and Malmo, information on fire hazards in Malmo buildings — including a basic description of the plant, records, location, nearest fire hydrants and other particulars of interest — was recorded in a computer and communicated to the Malmo fire department at the sound of an alarm. Much publicized was the fact that the information was stored on a General Electric Co. computer in Cleveland, leading Swedish politicians and others to speculate on the question of what would happen if access to that data base were prevented. How "vulnerable"

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> **"The Swedish government functions as a great storehouse of information, which could exert undesirable pressure if in improper hands."**

would Malmo be?

The committee subsequently assigned to address these issues, "Sarbarhetskommitten" (Sark), published its report in December 1979. Despite the fact that the report emanated from the Department of Defense, its findings are not confined to military preparedness; rather the risks and pressures implicit in the use of computers such as dependence upon foreign assistance, security and liability in the event of denial of access are carefully categorized and assessed. Although Sark recognizes the novelty of its perceptions in promulgating the report, some of its interpretations are already embodied in foreign (primarily European) data acts.

"Internal" factors inherent in computer use, previously mentioned, are considered together with external factors such as war (political and economic), terrorism and crimes against property which Sark holds may gain an entirely new dimension in an environment of high computerization of payment transactions. The report assumes that politically motivated acts of terrorism will continue to increase, becoming a crucial factor in national planning; and that Sweden's dependence on international data transmission circuits that transit several countries creates a vulnerability tied to the political stability of each of those countries.

The Sark report embraces worst-case analyses including enemy occupation in times of war, enemy capture of citizen information registers, the destruction or damage of computers and communications systems by the electromagnetic pulse effect of nuclear explosions and natural catastrophes affecting data banks internally and those extraterritorial data bases on which the country is dependent.

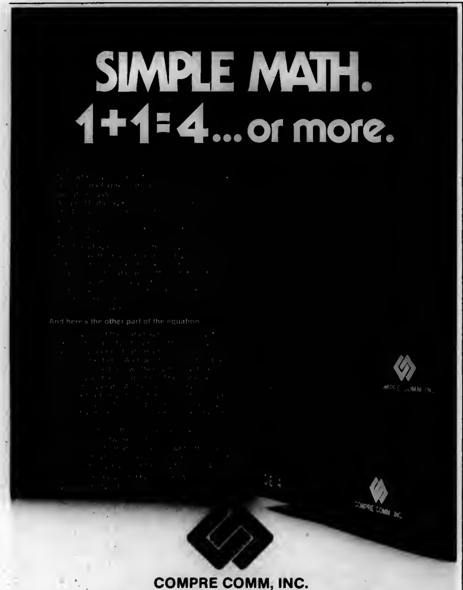
Swedish registers used in the study, for example, included social services, banking, inventory control and production scheduling.

Personal Vulnerability

As is generally characteristic of Sweden, occasions of computer vulnerability are also linked, closely in some cases, to privacy, implying a personal vulnerability as well as national vulnerability. In Sweden, the government performs a function of a great storehouse of personal and commercial information, including information of a confidential and strategic nature such as population registers linked to places of residence and information pertaining to the internal operations of private enterprises. All of this, Sark holds, could be used to exert undesirable pressure were the data to fall into improper hands.

It comes as no surprise, then, that Sark recommends inclusion of the Data Inspection Board among the authorities with primary responsibility for the vulnerability question. Furthermore, it is recommended that the Data Inspection Board be awarded the primary responsibility for licensing, supervising and examining all data bases in coordination with the Commander in Chief, the Telecommunications Administration, the Swedish Agency for Administrative Development and the National Board of Economic Defense.

Sark argues forcefully for effective emergency preparedness in response to the number and severity of factors present and contributing to national computer vulnerability. Also, linking vulnerability to informatics and economics, Sark implicitly suggests development of a national com-



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"Information sovereignty assumes the proprietary right of control over information, a right independent of DP or telecommunications."

puter industry (hardware and software) to reduce foreign dependency and therefore eliminate some of the factors contributing to vulnerability.

The investigative process and conclusions reached by the Swedish committee, while theoretically unique, may have broader impact. Other European countries are examining the Sark report with great care, inviting the assumption that implementation of its recommendations may not be limited to Sweden.

Information Sovereignty

A dictionary defines sovereignty as a state of being independent of all others or as a supreme and independent political authority. U.S. law defines sovereignty, in its full sense, as a "supreme, absolute and uncontrollable power by which an independent state is governed." For practical purposes, recognizing that every state is somewhat interdependent on many others and must therefore accept some restrictions on its actions, sovereignty becomes "the residuum of power which a state possesses within the confines laid down by international law," according to Starke, International Law.

As it refers to information, national sovereignty reflects a recognition of the economic, cultural and political significance of information and a concurrent desire and intent to cultural and economic interests by controlling the information resource and its distribution.

Inasmuch as information sovereignty closely overlaps our discussion of informatics plans, the subject of sovereignty — economic, cultural and informational — has already been introduced. However, the concept of information sovereignty can be differentiated from informatics in that it assumes the proprietary right of control over innate information, for nations and individuals — a right, moreover, which exists independent of either data processing or telecommunications.

The concept of "information sovereignty," of course, coupled with or underpinning a pervasive "informatics" plan, provides the intellectual basis or rationale for the most restrictive scheme of regulation of telecommunications and computer technologies, covering a broad spectrum of activity. Private- and public-sector procurement, use, export and import are only a few areas where new or revised rules can be established to give the government a firmer hand.

But "information sovereignty" is, or might become, far more pervasive in its interpretation and extension as it relates to the new technology. The concept is really technology-independent and, as such, may provide nations who seek a period of neo-isolationism an internationally respected shibboleth for drawing an information curtain around themselves. Although a contrary argument can be made that to do so may cut a nation off from the mainstream of world development, it is both difficult to make and at the same time ignores the fact that many nations, in one way or another, have often expressed their desire to withdraw from the interdependent world scheme of trade, finance, law enforcement or military preparedness.

This discussion of sovereignty and the evolution of the concept of information sovereignty are obviously most nascent — more so than "tele-informatics." Most legal scholars and diplomats would likely eschew linking the various political and technical developments around such a tentative conclusion; and indeed, the evidence is still sketchy and the foundation for assuring a redefinition of

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"Canada projects a loss of cultural autonomy with lost information sovereignty and has proposed vigorous laws to maintain them."

sovereignty is most infirm.

Yet, the pace of technological changes and its impact on existing institutional frameworks compels a candid assessment of even the "unthinkable" on the logical assumption that the worst-case scenario may actually occur. For example, if a major underlying concern of national politicians the world over is their increasing inability to deal effectively with the problems of their cities because national government is too big — or with the problems of the world because the nation-state is too small — then the challenges posed by a technology that is truly acultural and apolitical and promotes an ever more robust international transnational economic system for the world may be viewed most oppressively. It may theoretically justify, on a national scale, the most severe regulations on all information technologies and all information or data both entering or leaving a nation's borders.

Implications of 'Sovereignty'

Several nations, or at least prominent national leaders, are increasingly using the term "sovereignty" or "loss of sovereignty" when discussing information age issues. Equally, many are linking sovereignty and national plans for regulation or control of information or information technology.

Sweden, for example, associates a loss of privacy with lost sovereignty and, of course, vulnerability. So does France. Canada projects a loss of cultural autonomy with lost information sovereignty and has proposed vigorous plans for maintaining national economic and cultural sovereignty. The Clyne Commission Report on Telecommunications and Canada, while eschewing any assertion of supreme, independent power over all Canadian affairs, nonetheless postulates an urgent need for Canadians to secure, to the greatest extent possible, control over decisions affecting the future of the nation.

The principle is also reflected in U.S. law in the so-called *Fong* case, which specifies that "the preservation of national independence and security against foreign aggession or encroachment, *regardless of the form it may take,* constitutes the highest duty of every nation and to which nearly all other considerations should be subordinated" (emphasis added).

Clyne has defined telecommunications as the essential infrastructure of the new and future society; therefore, control over national life in the 21st century is contingent upon control of the infrastructure. The report prescribes a number of radical moves in the communications and data processing industries to theoretically contravene any loss of national independence, but which practically restrict or prohibit any penetration by international entities of the Canadian market.

These actions include government subsidy of national data banks, data processing organizations and distribution facilities and limits on satellite transmissions to those originating from Canadian satellites; and although it was later rejected, the committee reported a recommendation to delete all U.S. commercials from "transplant" programming as well as Canadian mass media communications.

Cultural Integrity

Perhaps for more justified reasons, less-developed countries increasingly express concern over cultural and political integrity, which they feel is threatened by "electronic colonialization" and "electronic imperialism." These emotion-packed phrases express perceived threats to national sovereignty.

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"The body politic in the U.S. has not fully grasped the significance of the emerging transborder data barriers and their impact."

Some technologies have already been the subject of intense (as yet inconclusive) debate — for example, earth-sensing satellites, which, in their geostationary orbits, transmit the space above all countries, gathering geographic, climatic and seismic data for global benefit. Earth-sensing satellites provide information on such various matters as crop conditions, mineral and fuels exploration, forest management, national resource inventories, flood control, pinpointing of fish concentrations for fishing industries and frost-edges for the citrus industry. The sovereignty argument, however, is mustered to contest free extraction of any data which, as a national resource, should not be exploited without proper compensation to the "originators" or owners of that information.

As interpreted by Clyne, and understood increasingly by less-developed countries, in the information age there will be two classes of people and nations: the exploiters and the exploited. Developing countries fear that in an unregulated global environment they will be precluded from later developing higher technological industries and services to serve their constituencies, either because necessary resources, such as the spectrum, are exhausted by then, or because entry into a market in competition with established, international service providers is practically impossible.

Policy Outlook

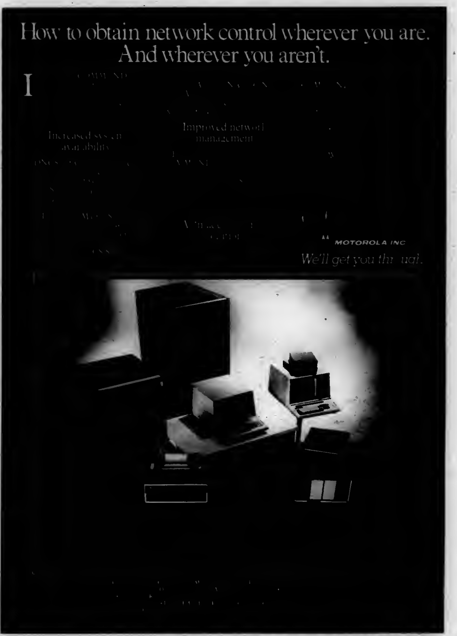
Privacy and data protection laws, taxes on information and increased tariffs and restrictions on telecommunications facilities will no doubt continue to proliferate in Europe, Canada and Japan. In addition, more direct control of international information flows everywhere appears likely as tensions rise over trade, unemployment and inflation. Coupled with the barriers to the free flow of information already erected by the Soviet Union and many less-developed countries, the U.S. and all nations dependent upon global information flows confront what may be one of the most complicated, convoluted issues of this century.

Censorship laws, data protection laws, tariffs, standards, information taxes, nationalization, computer vulnerability, information sovereignty, theft by computer-satellite link and information sabotage by "hunter-killer" satellites are all part of this global arena where nations are awakening to one of the world's oldest but most important resources: information.

These developments present an imminent threat to the world economy and all nations dependent upon the free flow of information across national borders.

In the U.S., where the communications revolution is most advanced, the threat is perhaps greater. However, although there seems to be a growing awareness of this phenomenon within both the public and private sectors, politicians, policymakers and the body politic in the U.S. have not yet fully grasped the significance of emerging transborder data barriers and their potential impact upon the use, production, storage and distribution of information throughout the world and what that means to the U.S. in a rapidly changing world economic setting.

Thus, the U.S. has focused little attention on the need for a comprehensive national communications and information policy. Indeed, responsibility for the development of U.S. policies in this field has been relegated to a number of governmental bodies without sufficient coordination or cooperation among them.



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"There are signs that the U.S. growth in high-technology industries may be slowing down due to a decline in research and development."

The need for a national communications and information policy (or policies) is becoming apparent. At a minimum, it must include:

(1) Continuation of an examination of regulatory practices that inhibit open competition in the domestic market for information products and services such as has been carried out by the FCC through its Computer Inquiry II, and as both the House and Senate have engaged in during the last few years.

(2) A review of copyright and relevant property laws to maintain appropriate incentives for innovations such as the National Commission on New Technological Uses of Copyrighted Works initiated.

(3) The clarification of the role of the public and private sectors in the development of computerized data bases and other information products and services, thus aiding in the refinement of the related laws of ownership, access and privacy. This is an area of increasing importance and seositivity as government itself balloons into the single largest "information" producer in our economy.

(4) The establishment of minimum standards to encourage the effective interchange of information on all societal levels.

U.S. policymakers face a formidable challenge in the vital tasks of integrating U.S. national communications and information policies with domestic policies regarding competition, copyright and privacy. Most important, they will then be interweaving those policies with U.S. foreign aid, foreign affairs and international economic policies. Yet the task of harmonizing domestic and international policy is central to development of a U.S. economic strategy.

There are also signs that the U.S. growth in high-technology industries may be slowing down because of a relative decline in U.S. research and development. This coincides with estimates indicating that the world market for telecommunications in 1987 will be $65 billion and in the U.S., by another estimate, the market for both equipment and services will rise to $88 billion in terms of adjusted "real" growth in the next 10 years.

Throughout this discussion are the recurring and central issues related to the U.S. world trade position, investment, innovation and R&D and the corollary issue of technology transfer. But on both trade and technology transfer, the U.S. has failed to articulate a coordinated national policy. After a two-year study of investment, innovation and R&D, the Carter administration failed to articulate its import and therefore failed to seize the leadership demanded. It is essential that U.S. leaders and representatives enter into every discussion and debate in which the information war is now being waged, with clearly defined national policies, for in these forums now meeting, the world's future information policy will be shaped and thus the economic future of the U.S. decided.

We must have international regulation and international agreements — it is inevitable. The only question, to put it simply, is whether the regulation we eventually are forced to live with is good or bad, well thought out and forward-looking or reactionary and cumbersome in its conception.

Against that understanding and acceptance of the need to act — not singly react, making a patchwork of myriad conflicting laws already in place, the U.S. should engage as many nations as possible — bilaterally, regionally or on an even larger scale — to examine such issues as communication and cultural integrity; educa-

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"To be specific, what is needed is a national and world focus on the implications of the new global communications phenomena."

tion, manpower and cultural interchange; access to and responsibilities of the mass media.

We also need to examine and seek agreement on several specific areas where the need for consistent, minimum regulation and new technological development come into play; for example, regarding communications equipment and standards, communications tariffs and facilities planning; and multilateral agreements to assure the privacy, confidentiality and security of the information being communicated.

For indeed, we need agreements on compatible equipment, standards and reciprocal certification to permit an affordable and yet effective interface of equipment systems — country to country.

Tariff Agreements

We need agreements that will preclude prohibitive tariffs within each country that would, for example, subject shared private-line systems to cost schedules based not on the cost of the leased line, but on a volume-sensitive, per-message basis.

And we need tariffs in each country to be cost-based and better harmonized nation to nation so that the cost of transmission per mile across a national border is not 10 to 20 times that of transmission over the same distance within those countries.

We also need to provide a forum or mechanism for underseas cable planning. In conjunction with our satellite planning process, we need to ensure such cable planning is made through a consultative procedure involving all parties concerned with the development of public facilities throughout the world (allowing, of course, for private design, development and innovation).

At a minimum, such planning should not be subjected to or unduly affected by unilateral decisions of a single nation-state. Specifically, the actions of one agency or instrumentality, such as the U.S. domestic regulatory agency, the FCC, should not be a source of continuing uncertainty or anxiety to such planning.

Regard for Confidentiality

Finally we need agreements that will preserve, not terminate, the confidentiality of all international transactions without dictating conflicting operating standards and procedures with which the user cannot successfully operate. Strongly differing views of privacy, security or protective enforcement of regulation can only create conflict between and among the nation-states.

New Focus

This dimension of our foreign relations offers a challenge both to our idealism and our ingenuity, our sense of mission and our common sense. It is the challenge of the last quarter of this century. For it is now evident that neither expanding crosscultural communication nor increasing trade necessarily leads to increased cooperation or understanding.

To be specific, what is needed is a national and world focus on the implications of the new global communications phenomena.

There is a difference between data and information; there is a difference between information flowing in the channels of communications and information products and services flowing in the channels of commerce. If one shall be wholly free and one only partially free and subject to trade restrictions, taxes and tariffs, the U.S. should play a leadership role in making that distinction. The stakes are too high not to play that role. Indeed, the stakes have never been higher.

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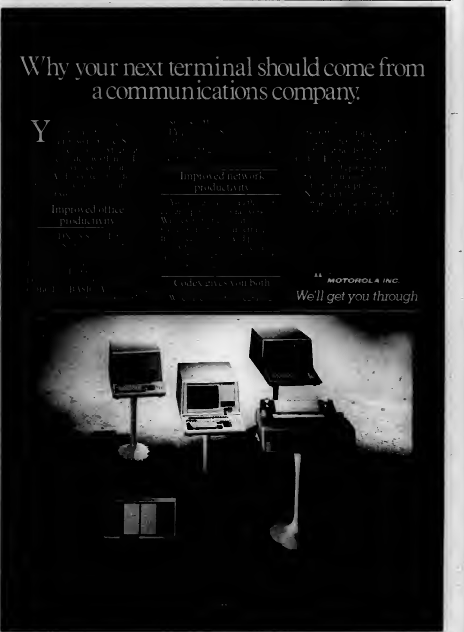

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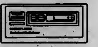

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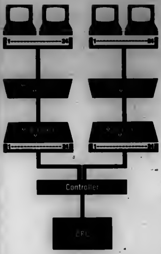

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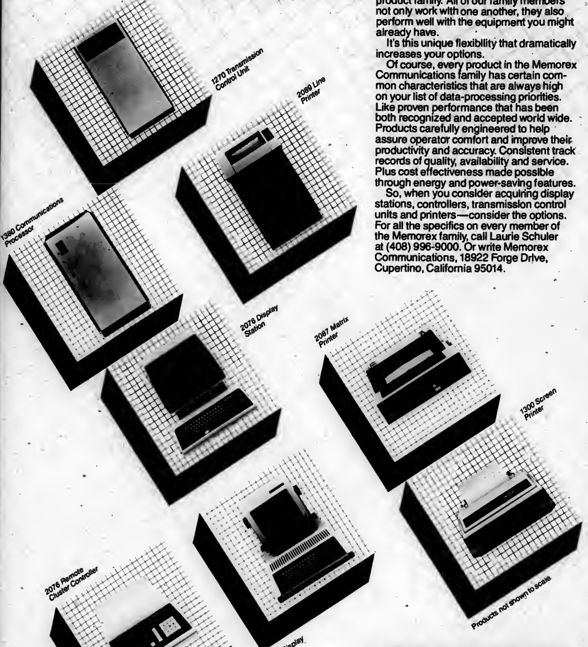
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